APRIL 1956
No. 213

ASTM Bulletin

PROVISIONAL PROGRAM
59th Annual Meeting
Atlantic City
June 17–22

American Society for Testing Materials

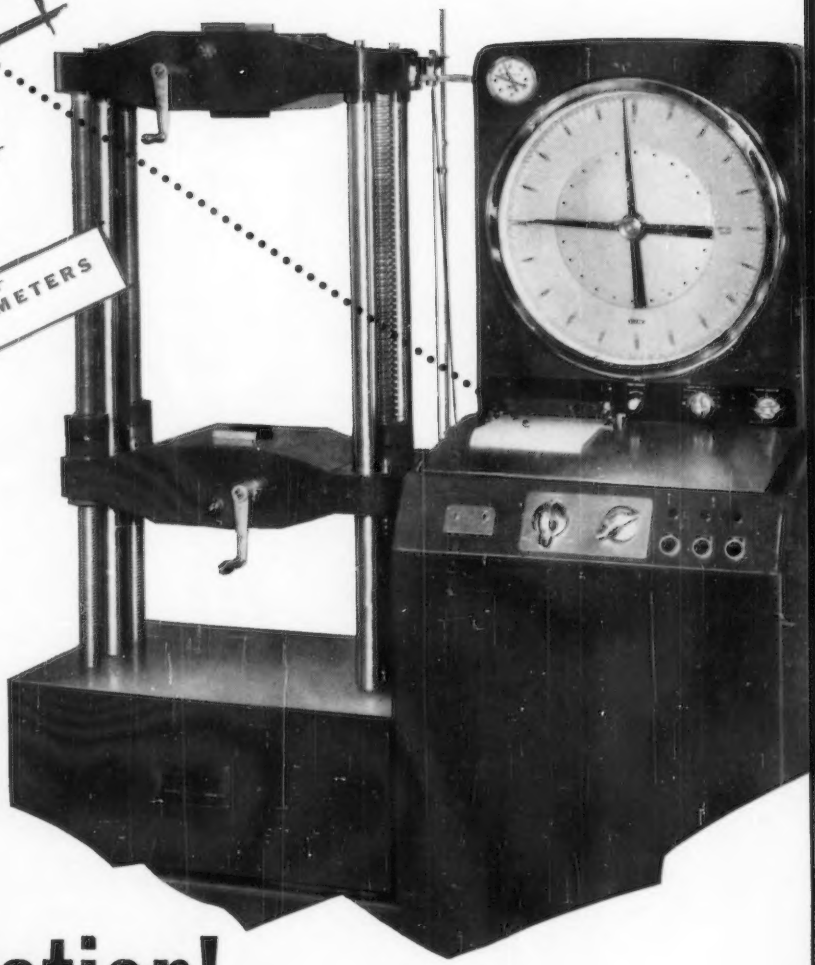
RECORDERS

STRAIN RATE INDICATOR

EXTENSOMETERS

DEFLECTOMETERS

COMPRESSOMETERS



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ASTM BULLETIN

APRIL 1956
Number 213

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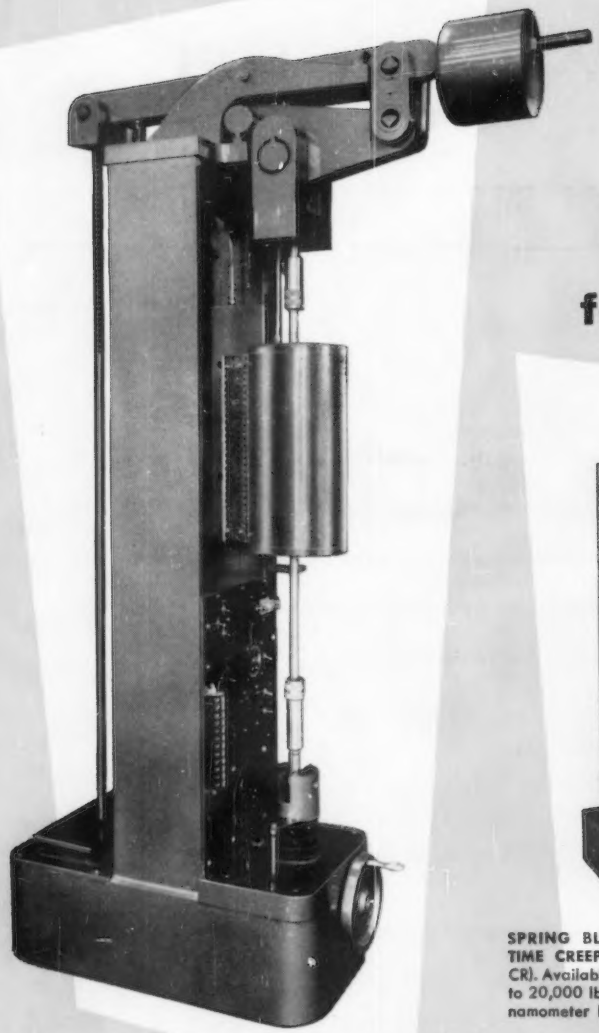
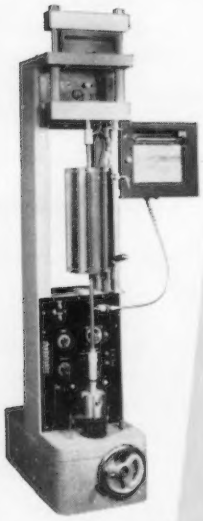
3 NEW MACHINES

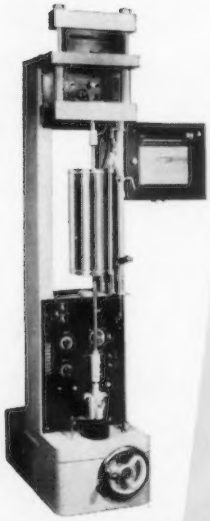
for better creep testing



LEVER TYPE FOR LONG-TIME CREEP TESTS. Model CL-20 (20,000 lbs. capacity). Load applied by dead weights. Lever ratio of 40 to 1 means less lifting for operator. Automatic take-up keeps lever arm horizontal as specimen elongates. Specimen fracture produces minimum shock since weights are maintained a fraction of an inch above base. Accuracy within ½% of load or 0.1% of capacity.



SPRING BLOCK TYPE FOR SHORT TIME CREEP RUPTURE TESTS. (Model CR). Available in 5 capacities, from 1,000 to 20,000 lbs. Load applied through dynamometer by motor-driven screw jack.



SPRING BLOCK TYPE MACHINE FOR AUTOMATIC CREEP RELAXATION TESTS. Model CX-04 (4,000 lbs. capacity).

Only from Baldwin can you get exactly the right machine for each type of creep test. All three Baldwins are built on the same basic frame, so you can "convert" your machine by changing the head and accessories. Every Baldwin creep testing machine has these advantages:

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- **Recorder can be mounted on machine or on centralized panel board.**
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- **Spherically seated pull rods assure axial loading.**
- **When specimen fails, shock to adjacent machines is minimized by new shock-absorbing base.**
- **Machine requires no special foundation, and need not be bolted to the floor.**
- **Performance-proven electric contact type extensometer gives best zero stability and widest range of magnifications.**

A new bulletin on Baldwin Creep Testing Machines is just off the press. Write Dept. 1503, Electronics & Instrumentation Division, BLH Corporation, 806 Massachusetts Avenue, Cambridge, Mass.

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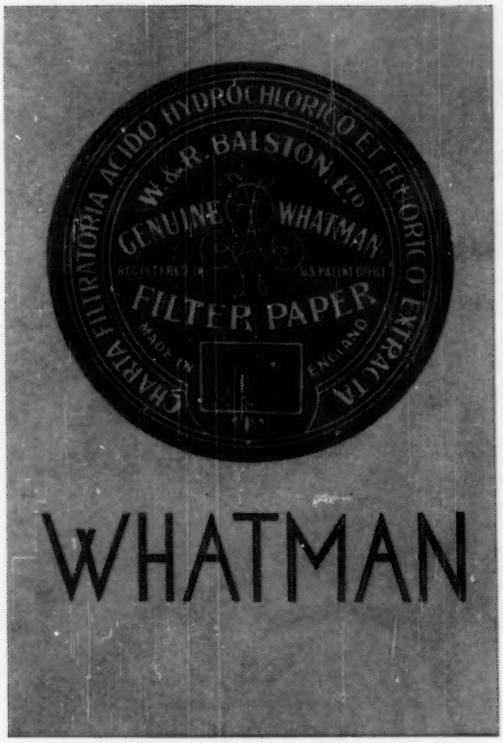

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ASTM BULLETIN

"Promotion of Knowledge of Materials of Engineering, and Standardization of Specifications and Methods of Testing"

Number 213 April 1956

59th Annual Meeting—Big Technical Program, Lectures on Silicones and Copper—June 17–22

Technical Committee Meetings, Apparatus and Photographic Exhibits

In 32 sessions, hundreds of technical committee meetings, two authoritative lectures by men outstanding in their fields, an Exhibit of Technical Apparatus and Equipment, the 59th Annual Meeting of ASTM will offer something of value to every engineer, researcher, and technologist in the field of materials.

In addition to the concentrated technical program, members and guests will find time to take in the special events and entertainment offered during the week as well.

Technical Program

As the Provisional Program (which appears on the following pages) indicates, the 32 technical sessions include the following eight symposiums:

- Rheology
- pH Measurement
- Tension Testing of Nonmetallic Materials
- Solder
- In-Place Shear Testing of Foundation Soil by the Vane Method
- Specific Gravity of Bituminous Coated Aggregates
- Ion Exchange Resins & Chromatography
- Steam Testing

Further extending the scope and diversity of the meeting are sessions on the subjects of:

- Metals
- Concrete
- Fatigue
- Stainless steel
- Testing (general)
- Soils

Marburg Lecture—Silicones

Charles E. Reed, general manager, Silicone Products Dept., General Electric Co., Waterford, N. Y., will deliver the thirtieth Marburg Lecture on a subject of considerable current interest—silicones.

This lecture originated as a memorial to the first secretary of the Society and was established to emphasize the importance of furthering our knowledge of properties and testing of engineering materials.

In his lecture entitled "The Industrial Chemistry, Properties, and Applications of Silicones," Mr. Reed will discuss the basic chemical structure of silicones with particular reference to their similarities and differences compared with other industrially important polymeric substances, and the physical and chemical properties of silicones leading to their industrially important applications. He will then take up processes of manufacture, the important types of silicones and their applications, ending with a look into the future of silicones in selected industries such as electrical, aircraft, protective coating, and textile.

Gillett Lecture—Copper

D. K. Crampton, director of research and development, Chase Brass & Copper Co., Inc., Waterbury, Conn., will present the fifth Gillett Memorial Lecture on Tuesday afternoon. His subject: "Structural Chemistry and Metallurgy of Copper."

This lecture, jointly sponsored by ASTM and Battelle Memorial Inst., commemorates Horace W. Gillett, the first Director of Battelle and one of this country's leading metallurgists.

In his lecture, Dr. Crampton will explore three aspects of microstructure of copper. The first portion will cover some new work on recrystallization ann grain growth of copper alloys, investigating time intervals much shorter than have been used heretofore. In the second portion the lecturer deals with the structural chemistry of copper and copper alloys and more particularly the relation of grains and grain boundaries both in pure copper and some copper alloys. Lastly, Dr. Crampton will describe new investigations of the fundamentals of corrosion and corrosion resistance of copper and some of the factors affecting the incidence growth of corrosion pits.

Committee Meetings

The detailed list of committee meetings to be held throughout the week will be included in the program given out at the Annual Meeting. An advance tentative outline of these committee meetings was included in the April 6 letter to members transmitting hotel reservation forms. As has been pointed out in the letter, members should consider the committee meeting schedule as tentative, to be superseded by the call of meetings by committee officers; in other words the official notice for committee meetings and subcommittee meetings will be received directly from the secretary of each committee. As we go to

The Provisional Program

of the 59th Annual Meeting which begins on page 15 is designed to give you a comprehensive preview of the symposiums, sessions, and special events of the meeting. You will find brief abstracts of the papers which will be presented and statements of the scopes of the symposiums.

The official program, which registrants will receive at the meeting, will contain full and final details of the sessions, a complete schedule of committee meetings, and the when and where of entertainment features of the week.

This shoreline view of Atlantic City's seaside hostelries shows the hotels cooperating

1. Haddon Hall 2. Chalfonte 3. Lafayette 4. Colton Manor

press the following committees plan to meet:

A-1 Steel—Sunday, Monday, Tuesday
A-2 Wrought Iron—Tuesday
A-3 Cast Iron—Thursday, Friday
A-5 Corrosion of Iron and Steel—Monday, Tuesday
A-7 Malleable-Iron Castings—Wednesday
A-9 Ferro-Alloys—Wednesday
A-10 Iron-Chromium, Iron-Chromium-Nickel and Related Alloys—Thursday
B-2 Non-Ferrous Metals and Alloys—Monday, Tuesday
B-3 Corrosion of Non-Ferrous Metals and Alloys—Thursday
B-5 Copper and Copper Alloys, Cast and Wrought—Monday
B-6 Die-Cast Metals and Alloys—Tuesday, Wednesday
B-7 Light Metals and Alloys, Cast and Wrought—Monday, Tuesday
C-1 Cement—Wednesday, Thursday
C-3 Chemical - Resistant Mortars—Monday
C-4 Clay Pipe—Monday, Tuesday
C-7 Lime—Thursday, Friday
C-9 Concrete and Concrete Aggregates Monday, Tuesday
C-11 Gypsum—Thursday, Friday
C-12 Mortars for Unit Masonry—Wednesday
C-15 Manufactured Masonry Units—Monday, Tuesday
C-17 Asbestos-Cement Products—Wednesday
D-1 Paint, Varnish, Lacquer, and Related Products—Monday, Tuesday, Wednesday
D-2 Petroleum Products and Lubricants—Monday through Friday
D-4 Road and Paving Materials—Monday, Tuesday, Wednesday
D-5 Coal and Coke—Sunday, Monday, Tuesday, Wednesday, Thursday
D-6 Paper and Paper Products—Thursday, Friday
D-8 Bituminous Waterproofing and Roofing Materials—Wednesday, Thursday, Friday
D-9 Electrical Insulating Materials—Wednesday, Thursday, Friday
D-11 Rubber and Rubber-Like Materials—Wednesday, Thursday, Friday
D-16 Industrial Aromatic Hydrocarbons and Related Materials—Tuesday, Wednesday
D-17 Naval Stores—Thursday
D-18 Soils for Engineering Purposes—Wednesday, Thursday, Friday
D-19 Industrial Water—Wednesday, Thursday, Friday
D-20 Plastics—Monday, Tuesday, Wednesday
D-24 Carbon Black—(Organization Meeting)—Friday
E-1 Methods of Testing subcommittees—Tuesday, Wednesday, Thursday
E-2 Emission Spectroscopy—Wednesday, Thursday, Friday
E-3 Chemical Analysis of Metals—Sunday, Monday, Tuesday, Wednesday
E-4 Metallography—Monday, Tuesday Wednesday
E-5 Fire Tests Sub. IV—Friday
E-7 Nondestructive Testing—Wednesday, Thursday, Friday
E-9 Fatigue—Wednesday
E-11 Quality Control of Materials—Tuesday
E-12 Appearance—Monday
Joint Committee on Effect of Temperature on Properties of Metals—Tuesday, Wednesday, Thursday,
Joint Committee on X-Ray Diffraction Data—Thursday

with the Annual Meeting Headquarters Hotel, Chalfonte-Haddon Hall.

5. Morton 6. Seaside 7. Claridge 8. Dennis 9. Shelburne

Preprints of Papers and Reports

Each member should have received by now the preprint request blank mailed to all ASTM members on April 13. The First Installment of preprints should go in the mail about May 11 and all papers and reports requested in this first installment will be included in this mailing. A second and third installment of preprints will be mailed on June 1 and June 15, respectively. Those registering at the Annual Meeting will have another opportunity to secure preprints of the various reports and papers. It should be borne in mind, however, that not all reports and papers will be available in time to be preprinted.

Special Events

Members and guests can again anticipate a first-rate entertainment program for both the ladies and the men attending this meeting. These arrangements are in the experienced hands of the Philadelphia District Council who have served so ably as hosts to all the Society's meetings on the Jersey shore.

President's Luncheon

The Society's main function dealing exclusively with ASTM affairs and personalities is the President's Luncheon. Featured are the President's Address by retiring President C. H. Fellows; awards of honorary memberships to individuals of widely acknowledged eminence in the fields of work covered by the Society, or who have rendered especially meritorious service to the Society; awards to individuals who have rendered distinguished service to the Society along technical lines; and recognition of 50 and 40-year members. No other technical sessions are scheduled at this time and all committees have been requested to keep the period from 12 noon to 2:30 p.m. free so that all may attend the Luncheon.

ASTM Annual Dinner

The welcome break in the middle of a very busy week will be provided by the Annual Dinner on Wednesday evening. A Dutch-treat cocktail party will precede the dinner and floor show which will feature nationally known entertainers. This event is strictly social—no speeches, no business—entirely set aside for relaxation and an opportunity to meet fellow members.

Hotel Reservations

Although Chalfonte-Haddon Hall will be the headquarters for the ASTM meeting, sleeping accommodations have been secured from the Colton Manor, Lafayette, Morton, and Seaside Hotels—all within a very short distance of the headquarters hotel. The Claridge, Dennis and Shelburne, other boardwalk hotels a few blocks below Chalfonte-Haddon Hall, have also put aside sleeping accommodations for our members.

THE MARBURG LECTURER . . .

Charles E. Reed, *who has been with General Electric Co. since 1942, is now general manager of the company's Silicone Products Dept., Waterford, N. Y. Beginning as a research associate, he became manager of the Chemical Engineering Department of the Chemical Division from 1945–1948 and manager of the Engineering Chemical and Metallurgical Division from 1948 to 1952. Dr. Reed's undergraduate degree was earned at Case Institute of Technology, his Doctor of Science in Chemical Engineering from Massachusetts Institute of Technology in 1937. He is a member of the honorary Sigma Xi and Tau Beta Pi. His technical and professional society affiliations include American Chemical Society and American Institute of Chemical Engineers.*

THE GILLETT LECTURER . . .

D. K. Crampton *has been with Chase Brass and Copper Co. since 1916 when he was graduated from Yale University with a degree in mechanical engineering. He subsequently obtained his Ph.D. in metallurgy from the same university. From 1921 to date Dr. Crampton has held the position of director of research and development with his company. Dr. Crampton has a long record of service in ASTM committees: Committees B-2 on Non-Ferrous Metals and Alloys; B-3 on Corrosion of Non-Ferrous Metals and Alloys; B-5 on Copper and Copper Alloys; E-2 on Emission Spectroscopy; and E-4 on Metallography; he was a director of the Society from 1950 to 1953. He is also a member of the American Institute of Mining and Metallurgical Engineers, American Society for Metals, and American Welding Society.*

Those members who have not as yet returned their hotel reservation form are urged to do so immediately. May 15 is the limiting date the hotels have given for making reservations.

A Plan for Better Presentation of Technical Papers

Continuing a plan which is intended to obtain livelier, more stimulating sessions by improving the character of presentations of technical papers, the Administrative Committee on Papers and Publications will again evaluate presentation of papers.

Reporters (not judges) will be chosen by each session chairman and asked to fill out a standard report card for each paper they hear. The check lists include items usually concerned with effective presentation. Copies will be sent, in advance, to each prospective author. During a presentation, the reporter, by check marks and one-word replies will complete a comprehensive, objective statement of what the speaker does and these statements will be evaluated by the Papers Committee. Any author may obtain his check sheet and learn how his presentation was received.

Ideas for refinement and improvement of the system will be welcomed from anyone; these should be sent to the chairman of the Administrative Committee on Papers and Publications at Headquarters. Volunteer comments on particularly well-presented papers would be especially helpful.

Photographers Attention!

May 19 is the deadline for having your technical photographs entered in the Tenth Photographic Exhibit and Competition. Application forms have been mailed to all members and committee members and additional copies are available on request. This is an opportunity to compare your work with others in the same and related industrial and technical photographic fields.

Photographic Exhibit and Traveling Print Show

The Tenth ASTM Photographic Exhibit and Competition will provide an interesting and educational diversion from the series of technical meetings and committee meetings. About 100 to 150 outstanding technical photographs are expected. They will be displayed in an area adjacent to the Apparatus Exhibit.

The Traveling Print Show of the Photographic Society of America will also be on display. It contains 31 photographs selected from the Eleventh Open Exhibit of Technical Photography, held in Boston in 1955. There are photographs in the fields of atomic research, botany, and biology. Also included in the show are underwater views, medical pictures, and studies of wind-tunnel experiments. The technical aspects of the photographs are as varied as the fields covered. Examples of photomicrography, macrophotography, radiography, and high-speed photography are included.

Exhibit of Testing and Scientific Apparatus, Laboratory Supplies

Leading Manufacturers Show Equipment of Special Interest in ASTM Testing and Research

THE SOCIETY'S Twelfth Exhibit of Testing and Scientific Apparatus and Laboratory Supplies will be an outstanding attraction of the Annual Meeting. At this Exhibit, held every other year, the latest in research and testing apparatus will be displayed by the country's leading manufacturers. Hundreds of items from small, hand-manipulated instruments through electronic control devices and high temperature ovens to universal testing machines will be exhibited. A fine group of companies have reserved space, many of them old friends to ASTM members, some new.

Exhibit hours are as follows:

Monday	12:00 noon– 9:00 p.m.
Tuesday	9:00 a.m.– 6:00 p.m.
Wednesday	9:00 a.m.– 5:30 p.m.
Thursday	9:00 a.m.– 6:00 p.m.
Friday	9:00 a.m.–12:00 p.m.

A brief description and pictures of the various kinds of apparatus that will be on display appear on the following pages.

Ace Glass Incorporated
Booth 58

Ace Glass will display a line of versatile, small-scale "minilab" apparatus with new additions; an electronic stirrer with a variable speed control; and a complete line of polyethylene ware including a new beaker of high temperature polyethylene.

ASTM Advisory Committee on Corrosion

The Advisory Committee on Corrosion the group within the Society responsible for correlation of all atmospheric exposure test site facilities that have been provided for ASTM technical committees, will with the help of the various interested technical committees display specimens of 17 per cent chromium and 18-8 stainless steel specimens which have been on exposure in the New York Area; nickel-chromium and copper-nickel-chromium platings on steel; various panels showing the effects of one-and two-coat paint systems of various formulas; aluminum and magnesium specimens from the "light metal program" of exposures at New York, Kure Beach, N. C., Freeport, Texas, and Point Reyes, Calif. There will also be a display of 9-by-12-in.-Koda chromeprints of the work of Committee A-5 on Corrosion of Iron and Steel; data from the specimens subcommittee calibrating the corrosivity of the various sites; and some small scale sandwich constructions. There will also be a special display of photographs showing the peculiar type of corrosion encountered in nuclear reactors.

American Cystoscope Makers, Inc.
Booth 44

Precision optical borescopes for visualization of relatively inaccessible surfaces will be demonstrated. These instruments incorporate integral illumination with incandescent lamp or ultraviolet lamp for use with fluorescing materials. The new ACMI precision optical flats of fused quartz and heat-resistant glass will be on display.

Holger Andreasen, Inc.
Booth 22

Holger Andreasen will display various models and capacities of Andrex Portable Industrial X-Ray Units and the Andro-scope Portable X-Ray Diffraction Stress Analyzer.

Atlas Electric Devices Co.
Booth 43

Atlas Electric Devices Co. will display their latest model Weather-Ometer for accelerated weathering tests on paint, varnish and related products, plastics, asphalt, rubber and other products which are subject to deterioration due to exposure to weather. Representatives will be available for discussing new developments, recommended testing conditions and techniques for the various types of products.

Atomic Energy of Canada, Ltd.
Booth 6

Atomic Energy of Canada will display a gamma radiography machine for non-destructive testing. Model GRM-500 has a capacity of 500 curies cobalt 60, resulting in greatly reduced exposure times—a factor of 100 over other machines using 5 curie cobalt 60 sources. This means that gamma ray exposures formerly requiring several hours can be done in minutes. Complete and up-to-date data on cobalt 60, iridium 192, thulium 170, and thorium 228 will be available.

Baldwin-Lima-Hamilton Corp.
Booths 16–19

Baldwin-Lima-Hamilton will display a universal testing machine, a creep machine, and a fatigue machine. The creep testing machine is a new lever type. A Model FGT testing machine of 50,000 lb capacity employs SR-4 Load Cells for measuring loads and can cycle loads automatically between any values of tension and compression loads. An SF-1-U fatigue testing machine of 1000 lb capacity will be equipped with a new type "manually adjustable while running" oscillator, steplessly adjustable from zero to 1000 lb.

C. W. Brabender Instruments, Inc.
Booth 33

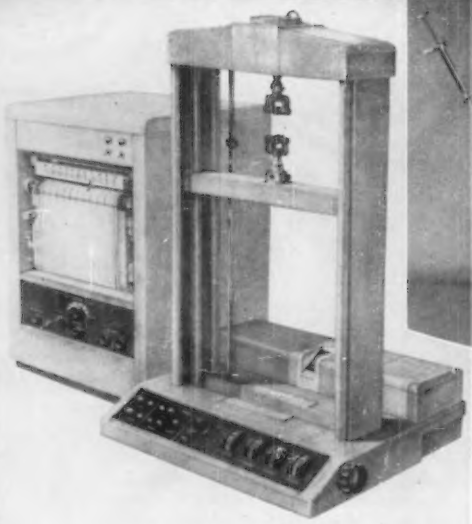
In this booth will be displayed the following: the new C. W. Brabender Plastograph with increased load range to 10 meter/grams for testing plastics and rubber; the new C. W. Brabender Visograph with three times the sensitivity and five times the viscosity range; the C. W. Brabender Circulating Pressure Thermostat with a range to 350 C; and the C. W. Brabender Rapid Moisture Tester with 0.1 per cent direct reading, optical Null-point adjustment, and automatically rotating turntable.

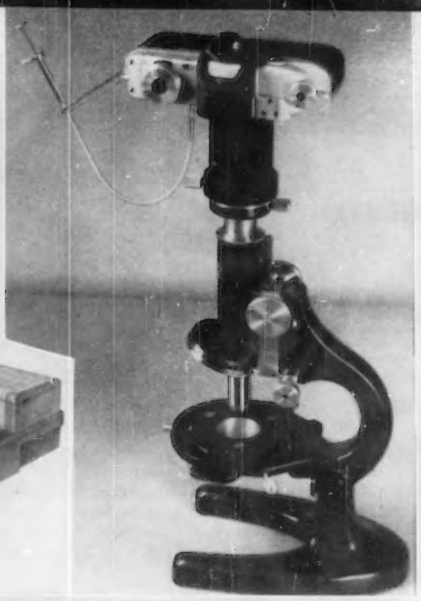
Branson Instruments, Inc.
Booth 4

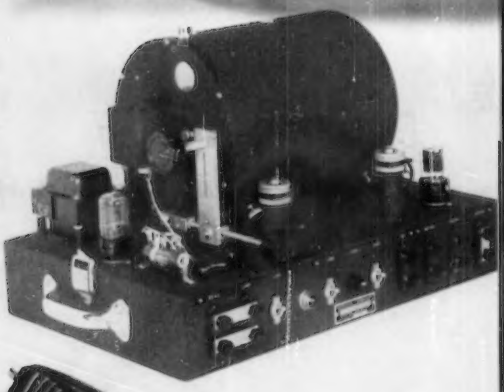
The Branson instrument exhibit will show new ultrasonic cleaning and testing equipment in operation. The "Vidigage" instruments use ultrasonic resonance for measuring metal wall thickness and detecting laminar flaws. Thickness is indicated on a 21-in. cathode-ray tube. Accuracies to 0.1 per cent are claimed, and thicknesses of 0.005 to 2.5 in. are shown on direct-reading scales. The "Sonogen" ultrasonic generators utilize ceramic barium titanate transducers to transmit intense ultrasonic vibrations into a liquid. Ultrasonic power is used extensively for degreasing, alkaline cleaning, plating, pickling, quenching, and other metal working applications.

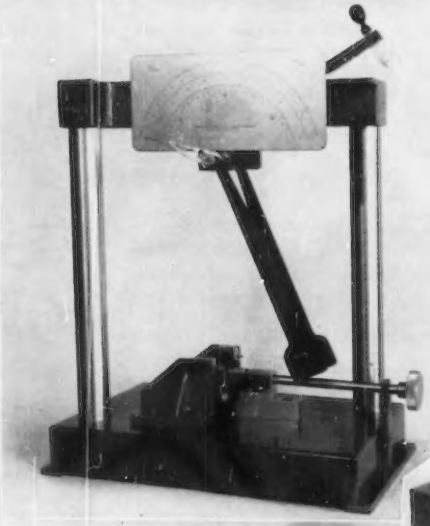
C. A. Brinkmann and Co.
Booth 51

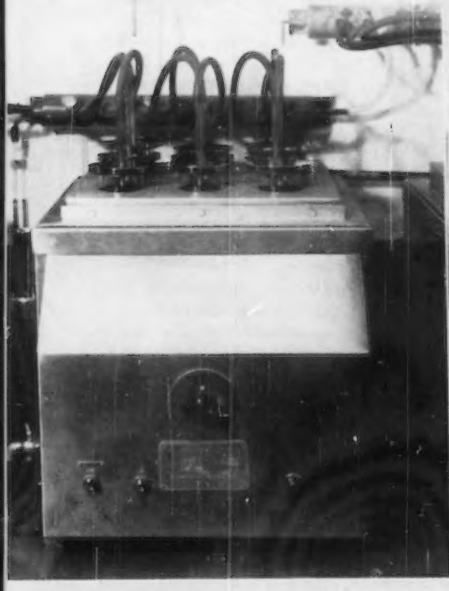
Brinkmann will show a number of new devices which have not been shown heretofore at ASTM meetings. The Balance Dept. will exhibit latest developments in rapid-weighing, single-and double-pan analytical balances; a new electronic vacuum balance and microbalances. The Optical Dept. expects to show a new Zeiss Table Model metallographic microscope, surface testers and photomicrographic apparatus with built-in exposure meters, also new types of Zeiss Stereo Microscopes for technical purposes and various types of industrial Micro Manipulators.











Buehler Ltd.
Booths 61 and 62

The new Buehler Automet Polisher will be on display and in operation at the Exhibit. This is a device for automatically preparing up to six metallurgical samples simultaneously. A new model of the Buehler Electro-Polisher and selected items from the complete Amsler line of testing machines will also be on display. Information on large test frames, jacks, and pulsating equipment will be available.

Burrell Corp.
Booths 59 and 60

Burrell Corp. will feature the Kromo-Tog, new unit-package instrument for the analysis of gases and volatile liquids by gas chromatography.

Using the principle of elution with either liquid partition or solid adsorbents, it is claimed scientists can determine the components of many mixtures far faster and more accurately than ever before possible.

Central Scientific Co.
Booth 27

Cenco will display several new pieces of apparatus. A new coulometric titrator is automatic in operation and designed especially for the determination of mercaptan sulfur content and H_2S in petroleum stocks and other organic liquids. The Cenco Automatic Mercaptan Titrator is capable of measuring low concentrations of mercaptan and provides the petroleum industry with a simpler and more accurate method for this important function in the control of refinery treating operations. The instrument will be adapted for bromine determinations through the use of accessory electrodes.

Curry & Paxton, Inc.
Booth 14

The Tintometer and Lovibond glass color standards will be exhibited. The Tintometer, according to the manufacturer, can measure color so accurately that there is no visual inaccuracy. Founded on the Lovibond system, the Tintometer is designed to impose controls necessary to a scientific technique when measuring color by limiting the field of view, providing a standard controlled illuminant, and permitting variation of matching color in a known manner. Lovibond permanent glass color standards are additive.

Custom Scientific Instruments, Inc.
Booth 36

Custom Scientific Instruments, Inc., will display the following: the Alundum Hot Plate and Cooling Coils for the Automatic Alundum Guarded Hot Plate console (Model No. 140-A), and automatic system for determining accurately the coefficient of thermal conductivity for various insulating materials; the Pittsburgh Corning Thermal Conductivity Probe in which temperature rises by an amount depending on the thermal conductivity of the material; the CSI-A Abrader for measuring abrasion of flat surfaces; the Electrostatic Voltmeter; the CSI Dividing Head (4-in. swing) and comparison Rotary Table (5-in. diameter) for profiling, drilling, light milling, layout work and engraving; the Microscope Stage; the CSI Templin Calibrator for precision checking of extensometer strain gages, dial gages, and test indicators; and the CSI Long Life Sieves for routine hourly sieve analysis of cement.

Doble Engineering Co.
Booths 56 and 57

The Doble Water-in-Oil Meter for continuously indicating or recording the water content even at values below saturation in a flowing stream of insulating oil will be shown making measurements. In addition the alarm system provided with the instrument to give either an alarm, a shutdown of operations, or both, when any predetermined saturation level is exceeded will be demonstrated. Various tests and apparatus such as the Doble Oxidation Comparator for evaluating transformer oils will be on display. The latest in the Doble line of power factor test equipment for both solid and liquid insulation will also be shown.

Eastman Kodak Co., X-Ray Division
Booth 23

Eastman Kodak Co. will display its full line of X-Ray processing chemicals, radiographs, and Kodak industrial X-Ray films.

Encyclopaedia Britannica, Inc.
Booth 30

On display will be the new 1956 edition of the Encyclopaedia Britannica, together with accessories and research reports.

Fisher Scientific Co.
Booth 10

Five major new instruments developed by Fisher Scientific Co. will highlight the Fisher apparatus booth. The Fisher-Gulf Partitioner (first commercial instrument to make full use of "gas-liquid partition chromatography," offering speedy, high-resolution, automatic qualitative and quantitative analyses of hard-to-analyze petroleum products, solvents, liquid fuels, flue gases, etc.); the Fisher Recordall (first universal lab recorder, converting manual instruments into recording ones, recording changes in current, resistance, temperature, pH, pressure, vacuum, illumination, etc.); the Coulomatic Titrimeter; the High-Frequency Titrimeter; and the unique Oscillating Hot-plate, which stirs as it heats, expediting lab operations.

General Electric Co.
Booths 52 and 53

General Electric Co., Instrument Department, will exhibit a large variety of specialty instruments. Among these will be two new products—the Small Particle Detector and the PM Thickness Gage.

General Laboratory Supply Co.
Booth 32

General Laboratory Supply will feature a new thermo-regulator accurate to $\frac{1}{100}$ C for controlling electrically heated baths, ovens, valves, and other electrically controlled apparatus. Made in a variety of ranges the Key-Thermo-regulator has a rotating magnetic adjustment for speed and ease of operation. A complete line of industrial thermometers, including Kimble with permanent filler, will also be shown. A high-frequency induction furnace by Lindberg Engineering for carbon and sulfur analysis in metals and sulfur in petroleum will be another feature of the display.

General Radio Co.
Booths 48 and 49

General Radio Co. will display instruments for measuring dielectric properties, insulation resistance, stress patterns, and noise, as well as a broad line of testing laboratory accessories.

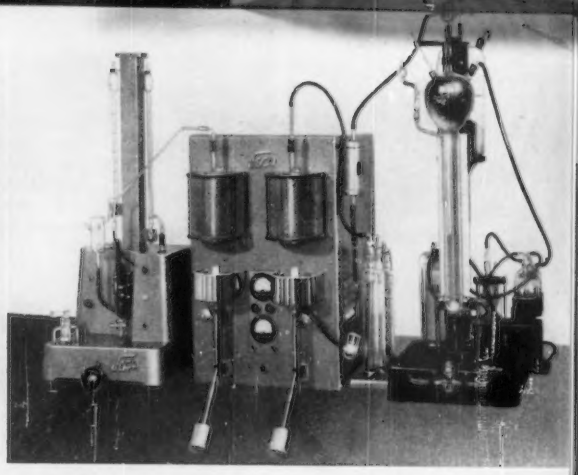
The Emil Greiner Co.
Booth 38

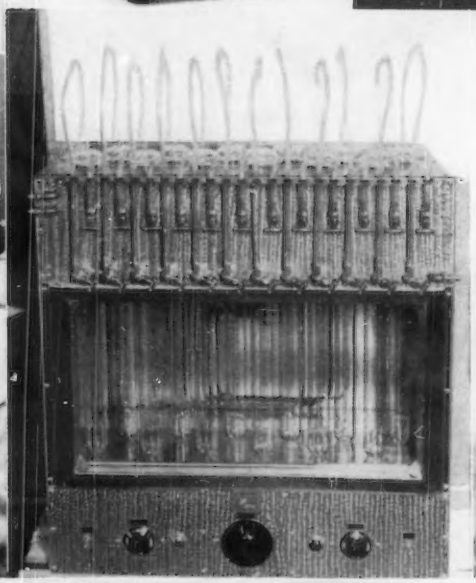
The Emil Greiner Co. will display several pieces of apparatus used in the petroleum field, including aluminum block apparatus for determining existent gum in fuels by jet evaporation; high-temperature Saybolt Viscosimeter for determining the viscosity of asphalts, road oil, and fuel oils; a turbine oil oxidation bath for determining the oxidation inhibitor life of inhibited turbine oils; an automatic aniline point apparatus which will determine aniline points in approximately one-fourth the time required by the present test methods; a new type pressure hydrometer jar for liquefied petroleum gases; and a low-temperature, mechanically refrigerated kinematic viscosity bath which can be adapted for use with Cannon-Fenske or Ubbelonde type viscosimeter.

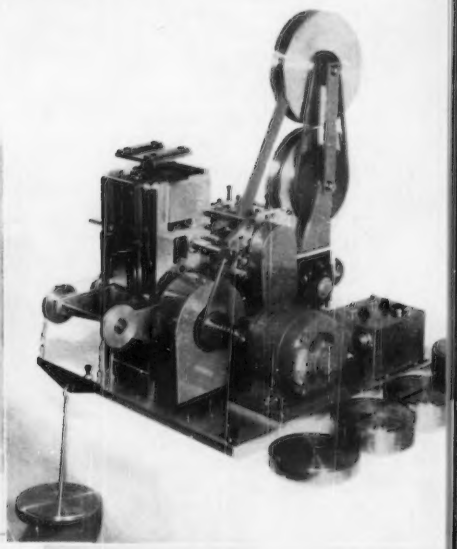
Karl Heitz, Inc.
Booth 11

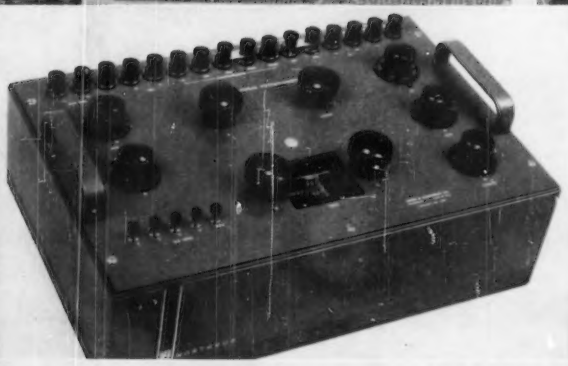
Karl Heitz, Inc., will show a wide variety of Swiss and other European precision optical equipment. The items range from the extremely compact PROJEC-

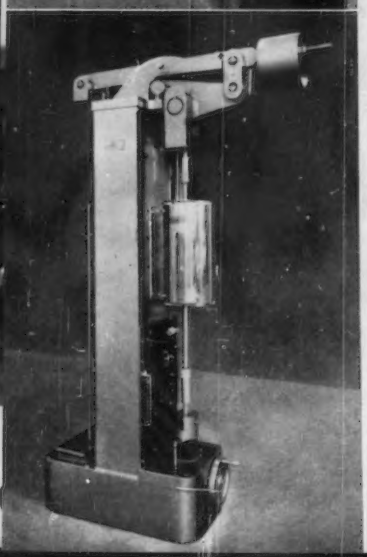
First row, left to right: table model testing machine, 200-lb maximum capacity for plastics, wire, textiles, and paper; microscope adapter and close-up stand for use with 35-mm single lens camera; interior assembly of photoelectric galvanometer; (below) PM thickness gage; analytical balance.
Second row, left to right: induction unit for carbon and sulfur determinations; impact tester for plastics and ceramics; aluminum block oven for pressure aging tests of elastomers; unit package instrument for analysis of gas and volatile liquids by gas chromatography; (lower insert) comparator for comparing colors.
Third row, left to right: oxidation comparator; gamma radiography machine for nondestructive testing; weatherometer for accelerated weather tests on paints.
Fourth row, left to right: industrial telescope for examining the interior of pipe, castings, etc.; analytical balance.

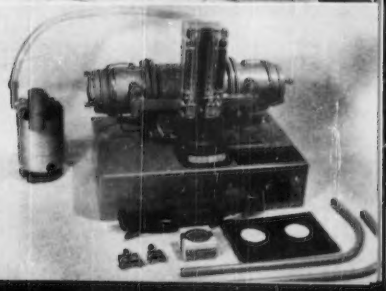












TINA combination macro/microscopic projector-viewer-camera to the small OMAG pocket microscope (10–50×) with built-in illuminating system (either 110-v a-c or AA dry batteries). Visitors may examine KERN prism binocular microscopes and optical flats, and the BLEEKER line of research and phase-contrast microscopes, universal and pocket refractometers, and pocket spectroscope as well. Also exhibited will be the Macrostat close-up stand and Microfix microscope adapter for the ALPA 35-mm single-lens reflex camera for recording microscopic findings and close-ups of tested materials.

Instron Engineering Corp.
Booths 46 and 47

On exhibit will be the new Table Model Instron, a compact unit designed for testing materials within its 200 lb-maximum load capacity. Incorporating the features of the larger Instron Testing Instruments, this model has applications in such fields as plastics, wire, textiles, and paper. This company's exhibit will also include the new X-Y Recorder for extensometer use, as well as the regular line of Instron testers and accessories.

Laboratory Equipment Corp.
Booth 3

Displayed will be a completely new line of LECO High Frequency Induction Furnaces for the analysis of carbon and sulfur in iron and steel. Also to be shown will be an induction furnace unit for analyzing sulfur in hydrocarbons. This will be an operating exhibit, and chemists are invited to bring samples to be analyzed as unknowns.

Leeds & Northrup Co.
Booths 1 and 2

In Leeds & Northrup's booths, a new Type K-3 Universal Potentiometer will demonstrate its easy reading, guarding, and thermal free features by comparing a number of standard cells. A Speedomax AZAR Recorder will record the load exerted on a plastic block; polarized light will visually show the strain. The widely used, line-operated pH Indicator will team up with a new Speedomax H Recorder to plot pH values.

Lindberg Engineering Co.
Booth 25

Lindberg Engineering Co., Laboratory Equipment Division, will display equipment for generating and utilizing protective atmospheres at elevated temperatures for research and pilot type heat treating applications. The new model of the "H-F" induction unit for carbon and sulfur determinations in a wide variety of materials including metals, hydrocarbons, organics and inorganics, will also be demonstrated. Information concerning standard heating products for the laboratory, hotplates, furnaces, etc., will be offered by the manufacturer's staff.

Mettler Instrument Corp.
Booth 24

The Mettler Instrument Corp. will exhibit instruments from its line of single-pan analytical and precision balances. These instruments are designed for high speed, simplicity of operation and dependable accuracy for testing operations where weight is a critical factor. The Mettler exhibits will be highlighted by models from its newest line of precision balances featuring a built-in taring devices which makes possible direct reading of net weight in three to five seconds.

National Forge & Ordnance Co.
Booth 5

National Forge and Ordnance Co. is featuring this year a newly designed four-range impact tester for metals along with a small impact tester for plastics and a small compression tester for general compression crush tests of plastics, wood, paper, and related products. Various tools and accessories will also be displayed.

North American Philips Co., Inc.
Booth 50

X-rays at work will highlight the Norelco exhibit showing X-rays on the production line inspecting components and welds by means of the Norelco "MG" series with a variety of differently designed units to cope with a wide range of problems; X-ray analysis of crystal structure and elemental composition of matter with Norelco diffraction and spectrography; electron microscopy with the new Norelco EM-75; and radiation detection with a sensitive pocket-size battery monitor.

Tinius Olsen Testing Machine Co.
Booths 20 and 21

Olsen will exhibit in operation their 12,000-lb Electomatic universal testing machine with load cells, X-Y Recorder, true strain rate indicators, and program controlier. Also an Air Operated Brinell tester; a Charpy impact tester; Conbel soil tester with recorder; and Penetrayscope and hardness tester.

Parr Instrument Co., Inc.
Booth 37

A new self-sealing oxygen bomb that can be operated either in the conventional or in an "upside-down" position will be featured in the Parr exhibit. The display will include a complete assortment of oxygen and sodium peroxide bombs for calorimetry and combustion tests, and an adiabatic oxygen bomb calorimeter with accessories for measuring heats of combustion of solids and liquids. There will also be an exhibit of pressure reaction apparatus with 1- and 2-liter stainless steel bombs for chemical reactions and tests at pressures to 1000 psi and temperatures to 350 C.

Research Appliance Corp.
Booth 35

Research Appliance specializes in precision-machined research and testing equipment. At their booth there will be a Dill Dust Spot Tester for measuring the efficiency of all types of air filters, an extensometer for measuring elasticity of plastics, and a self-ignition apparatus for testing spontaneous ignition temperatures of combustible liquids. The exhibit will also include corrosion-resistance laboratory pumps used for pumping and measuring practically all chemical liquids.

Riehle Testing Machines Division, American Machine and Metals, Inc.
Booths 40 and 41

The Riehle booth will feature a new creep-rupture testing machine with complete instrumentation, including high-temperature extensometer and autographic time-elongation recorder. Also on display will be a universal screw-power testing machine with high magnification stress-strain recorder and other instrumentation; portable hardness testers for Rockwell readings; and two portable Vickers hardness testers—one for general purpose and one for gear hardness.

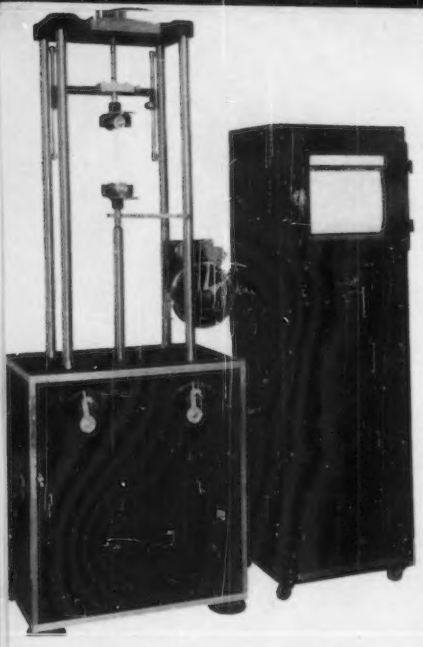
Rubicon Co.
Booth 45

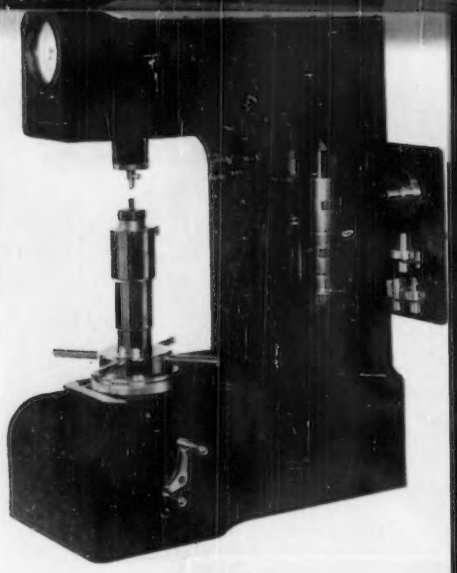
Rubicon will exhibit a representative group of its well known electrical measuring instruments. Included will be a potentiometer and null detector for exacting laboratory measurements to within 0.01 microvolt, and portable potentiometers for high-accuracy field measurements. A versatile, new portable precision potentiometer for thermocouple measurements and calibration of recording potentiometers will also be shown. This instrument extends the technique of manual reference junction compensation to subzero as well as above-zero temperature measurements.

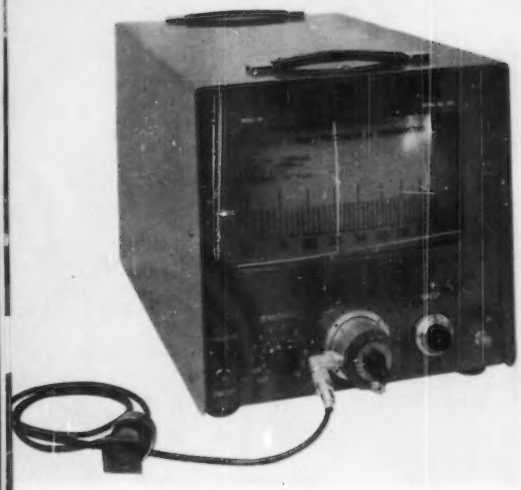
Scott Testers, Inc.
Booths 8 and 9

Scott Testers, Inc., will feature three new developments in their extensive line of testing apparatus for rubber, wire, textiles, paper, leather, and plastics. These will be shown for the first time anywhere: an entirely new design of the Mooney Shearing Disc Viscometer representing the culmination of 13 years' experience with the well-known Model NBS; an entirely new variable speed, variable capacity physical testing apparatus de-

First row, left to right: bomb calorimeter; d.c. amplifier and electrometer; high-frequency induction furnace for analysis of carbon and sulfur in iron and steel.
Second row, left to right: qualitative and quantitative instrument for gas-liquid partition chromatography; turbine oil oxidation bath; abrader for measuring resistance to abrasion of flat surfaces.
Third row, left to right: Polisher for automatically preparing up to six metallurgical samples simultanously; universal (guarded) potentiometer; industrial X-ray unit.
Fourth row, left to right: lever-type creep testing machine; automatic titrator; Dill dust spot tester.







First Row, left to right: Electro hydraulic tension tester; creep-rupture testing machine; hardness tester. Second Row Ultrasonic technique tester, 12,000-lb universal testing machine; microhardness tester.

signed for the vastly extended requirements of modern day industry; the new Model LGP Aluminum Block Oven for pressure aging tests of elastomers in their air or oxygen in which the specimens are segregated in individual sealed containers to eliminate errors due to possible contamination between specimens.

Service Diamond Tool Co.
Booth 31

Service Diamond Tool Co. will display its hardness testing machines and accessories for both standard and superficial Rockwell testing.

Thwing-Albert Instrument Co.
Booth 13

Thwing-Albert Instrument Co. will exhibit instruments for measuring physical properties of materials. Featured will be the latest Model 49RC-1-12 Electro-Hydraulic Tensile Tester which will be displayed with the new type of "X-Y" recorder which provides 1 to 1000 chart magnification. Also on display will be a recent development, the Ply Adhesion Tester, made in accordance with ASTM Method D 825, Method A. Other exhibits are the Handle-O-Meter, of interest in the paper, textile, plastic, and light metals fields. The new Four-Square Cutter and the new Alfa Cutter will be included in the group of precision sample cutters. The Elmendorf Tearing Tester will be shown fitted with the new textile augmenting weight for very heavy textiles.

Wheeler Co., Inc.
Booth 28

On display will be the Wheeler Testing Vibrator designed for sieves from 6 to 16 in. in diameter, suitable for either laboratory or field use in grading either coarse or fine material. Special engineering features include precision-ground, double-shielded ball bearings throughout; automatic variable speed drive pulley; and aluminum alloy castings to minimize weight. Vibrators may be powered by either electric motors or gasoline engines.

Wilson Mechanical Instrument Div., American Chain & Cable Co., Inc.
Booth 15

Wilson will show its latest design Rockwell, Rockwell Superficial, and Tukon Microhardness testers. They will also display the Semi-Automatic (Y Model) and accessories for the Rockwell testers.

This Program is Subject to Change

PROVISIONAL PROGRAM

Fifty-Ninth Annual Meeting

AMERICAN SOCIETY FOR TESTING MATERIALS

ATLANTIC CITY, N. J. • JUNE 18-22, 1956

All time indicated is Eastern Daylight Saving Time

Committee Meetings held throughout the week

MONDAY, June 18	TUESDAY, June, 19	WEDNESDAY, June 20	THURSDAY, June 21	FRIDAY, June 22
MORNING				
	5 Symposium on Solder 6 Symposium on pH Measurement	15 Symposium on Solder 16 Metals Session	21 Fatigue Session	29 Symposium on Rheology 30 Symposium on In-Place Shear Testing of Foundation Soil by the Vane Method
	—11:30 a.m.— 7 Report Session (Reports A-1, C-2, C-3 C-4, C-8, E-5, E-6)	—11:30 a.m.— 17 Report Session (Reports C-14, C-16, C-21, C-22, D-4, D-5, D-20)	—11:30 a.m.— 22 Report Session (Reports C-12, C-19, D-7, D-12, D-14, D-21, D-22, D-23, E-10)	—12:00 noon— 31 Report Session (Reports C-7, C-11, D-2, D-3, D-8, D-11, D-15, D-18. 32 Report Session (Reports A-3, D-6, D-9, D-10, E-2, E-7, E-13, E-14, F-1)
	—12:00 noon— 8 Luncheon Session, President's Address, Awards			
AFTERNOON				
1 Opening Session—Symposium on Specific Gravity of Bituminous Coated Aggregates	9 Symposium on Solder 10 Symposium on pH Measurement	18 Symposium on Tension Testing of Non-Metallic Materials (Report E-1)	23 Fatigue Session 24 Stainless Steel Session . (Report A-10, Jt. Comm. Effect Temp., Adv. Comm. Corrosion)	
	—4:30 p.m.— 11 Report Session (Reports A-5, C-9, C-13, C-15, C-18, C-20, E-11)	—4:00 p.m.— 19 Report Session (Reports A-7, A-9, B-2, B-6, D-1, D-13, D-16, E-3, E-4, E-9, E-12)	—4:30 p.m.— 25 Report Session (Reports B-1, B-3, B-4, B-5, B-7, B-8, B-9, C-1, D-17)	
	—5:00 p.m.— 12 Gillett Lecture, D. K. Crampton Copper	—4:30 p.m.— 20 Marburg Lecture, C. E. Reed Silicones		
EVENING				
2 Metals Session 3 Concrete Session 4 Symposium on Ion-Exchange and Chromatography in Analytical Chemistry	13 Metals Session 14 Symposium on Solder	Cocktail Party ASTM DINNER Entertainment Dancing	26 Symposium on Steam Quality (Report D-19) 27 General Testing Session 28 Soil Session	

ASTM Registration Desk opens Sunday evening June 17

NOTE.—It is possible that some of the papers listed in the following provisional program will be presented by title only. Consult the final program for this information.

Monday, June 18 2:00 p.m. First Session

Opening Session

Formal Opening of the Fifty-Ninth Annual Meeting. President C. H. FELLOWS.

Symposium on Specific Gravity of Bituminous Coated Aggregates

Subcommittee B-14 of ASTM Committee D-4 having subcommittee jurisdiction over Methods of Tests for Specific Gravity of Fine and Coarse Aggregates has prepared this symposium.

Specific gravity has an important role in the present-day design and the measurement of compaction of bituminous pavements.

Authors and discussors of the symposium are recognized authorities on the science of bituminous mixture design and placement. They have volunteered their services to present methods of test and field experience to establish a more comprehensive understanding of the subject.

The Role of Specific Gravity in the Design and Control of Bituminous Paving Mixtures. C. A. Carpenter, Bureau of Public Roads.

The design of bituminous paving mixtures for today's heavy-traffic roads requires maximum emphasis on stability. Of the several factors influencing stability, one of the most important is complete compaction at the time of construction. The mixture must be so designed that an excess of bituminous binder will not be used since this would prevent complete compaction and result in lowered stability. Accurate determination of the correct amount of bitumen cannot be made unless a method of determining the correct "practical" specific gravity of the aggregate is available. The practical specific gravity is intermediate between average apparent and average bulk specific gravity for all aggregates having an appreciable degree of absorptivity. It is the purpose of this symposium to explore workable and convenient ways of determining the practical specific gravity.

Measurement of Bituminous Concrete Core Densities and Density of Bituminous-Coated Aggregates by Means of a Volumeter. F. M. Williams, L. E. Grimmer, M. M. McAdams, and S. Yanoshek, Ohio State University.

Methods of measuring the volumes of bituminous concrete cores and loose bituminous-coated coarse aggregates by air-pressure changes are described. Densities obtained for cores cut from pavements are compared with densities of the same cores made by paraffin coating methods and densities by the use of volumes computed from height and diameter measurements. Variation in pavement density is shown by densities of 16 cores cut from 2 sq ft of pavement. The data cover limestone and gravel coarse aggregates with limestone and natural sands. Studies of density measurements of coated coarse aggregates are shown for limestones, gravels, and slags. Air method densities are compared with densities of same aggregate specimens immersed in bitumen. The use of the air method was found dependent on coatings impermeable to air.

Measurement of Maximum Theoretical Specific Gravity of a Bituminous Mixture by Solvent Immersion. Paul J. Serafin, State Highway Dept., Michigan.

This paper describes a method for the determination of maximum theoretical specific gravity of a bituminous mixture by a direct measurement. Briefly, this technique utilizes an adaption of a pycnometer method in which a bituminous mixture is placed in a large flask having a 1½-in. ground-glass opening in which is fitted a top with a restricted neck for more precise volume measurements.

A solvent, such as trichlor-ethylene, is introduced to dissolve the asphalt, thereby liberating the air voids in the mass. From the weights of the sample and the solvent used, the specific gravity of the voidless bituminous mixture can be determined by calculation.

Development and Application of the Effective Specific Gravity of Bituminous Coated Aggregates. J. Rogers Martin and Andrew H. Layman, Jr., Asphaltic Concrete Association of Oklahoma.

In the course of an investigation conducted by the authors in 1949 dealing with the design of hot mixes, some absorbtive aggregates were encountered. For the purpose of correcting for absorption, the "effective" specific gravity was developed—the specific gravity of the unfilled capillaries. Its use automatically corrects for absorption in arriving at the optimum asphalt content of the mix.

Briefly, it is determined by obtaining the specific gravity of a specimen overfilled with asphalt, after which the effective specific gravity is calculated from an equation.

Maximum Specific Gravity of Bituminous Mixtures by Vacuum Saturation Procedure. James M. Rice, National Crushed Stone Association.

This paper describes a method for measuring the maximum specific gravity of voidless samples of bituminous paving mixtures. The procedure consists of removing entrapped air from a known weight of uncompacted mixture by evacuation and saturation under water. The volume of the sample is then determined by water displacement, and specific gravity by the ratio of the dry weight to the weight of an equal volume of water. This measured maximum specific gravity may then be used to calculate the percentage air voids in compacted specimens of the same mixture. This procedure eliminates the need for conventional specific gravity tests on aggregates and bituminous material.

Specific Gravity and Voids Relationships in Bituminous Pavement Mix Design. J. L. McRae, Waterways Experiment Station, Corps of Engineers.

This paper analyzes briefly the basic problem of specific gravity of aggregates for use in calculating voids in bituminous mixes and discusses the latest specific gravity test procedure that has been developed by the Corps of Engineers. It points out that the voids in a pavement are a function of aggregate gradation as well as aggregate porosity and shows wherein methods for design and control based on specific gravity and voids are in certain instances difficult to apply, and points to the need for an improved method. It presents a brief discussion of a new approach being studied by the Corps for mix design based on the compaction phenomenon which may possibly eliminate the need for determining the specific gravity of the aggregate.

Monday, June 18 8:00 p.m. Second Session

Held simultaneously with Third and Fourth Sessions

Metals Session

Impact Properties of Quenched and Tempered Alloy Steels. J. P. Sheehan and Harry Schwartzbart, Armour Research Foundation.

The V-notch Charpy impact properties of the following alloy grades of steel in the quenched and tempered condition have been investigated over a temperature range from −320 to +700 F: 1300, 2300, 3100, 4100, 4300, 4600, 5100, and 8600. The effects of the following variables on impact properties and, specifically, on transition temperature have been determined: (1) tempering temperature (from as-quenched to 1200 F), (2) carbon content (from 0.20 to 0.80 per cent C), (3) alloy grade, (4) phosphorous content, (5) austenite grain size, and (6) anisotropy.

A Tensile Study of Brittle Failure in Mild Steel. E. T. Wessel, Westinghouse Electric Corp.

This investigation utilizes the sub-zero temperature tension test (as low as −452 F) to study the flow and fracture behavior of "as-rolled" ship plate. Emphasis is placed on the factors involved in initiating a brittle fracture rather than its propagation. The significant findings are concerned with measurements of the temperature dependence of the yield and fracture strengths, and the strain dependence of the fracture strength. The results indicate that plastic strain can seriously lower the stress required to initiate a brittle (cleavage) failure. A correlation of fracture appearance with the tensile properties obtained is also made.

Effects of a Number of Heat Treating and Testing Variables on the Notch Strength of 4340 Steel. George Sachs, Volker Weiss, and Eugene Klier, Syracuse University Research Inst.

The 4340 steel heat-treated to strength levels above 200,000 psi has been shown to become increasingly notch-sensitive as the notch radius decreases and as the testing temperature is reduced. At normal temperatures the notch sensitivity increases gradually as the tensile strength increases above 200,000 psi, and there is no indication of higher notch sensitivity in the range 500 to 700 F.

At a testing temperature of −100 F similar behavior is observed except that the 500 F embrittlement is indicated for the most sharply notched specimens. At −320 F all notched specimens to some degree reveal the 500 F embrittlement.

The intensity of the development of the 500 F embrittlement is dependent on the austenitizing and quenching program. The 4340 steel heat-treated to suppress the formation of upper bainite and oil-quenched from the holding temperature of 1325 F is notch-insensitive compared to the steel given the conventional heat treatment. However, structures formed during slow cooling even in the absence of obvious slack-quenched structures have reduced notch toughness.

The notch-tension test has demonstrated its usefulness for the evaluation of those

properties of ultra-high-strength steels which are of potential use for the designer and builder of aircraft and other structures. Valuable information in this respect can be derived from testing rather small specimens taken from readily available bar stock.

The magnitude of stress-concentration determines notch strength according to a simple universal pattern. Whenever a notch sensitivity exists it increases gradually as the stress-concentration factor becomes greater. For all tempering temperatures, notch radii, and testing temperatures the notch-strength ratio of 4340 steel depends upon stress concentration in the manner previously determined for another alloy steel. Tests at about −100 F on specimens provided with a sharp notch leading to a stress-concentration factor of about 10, therefore, are sufficient to establish the characteristics of the steel. For a general evaluation of the steel, tests on sharply notched specimens are highly preferable to tests on mildly notched test bars.

An Empirical Relationship Between Rupture Life and Minimum Creep Rate in Creep Rupture Tests. Forest C. Monkman, Walworth Co., Nicholas I. Grant, Massachusetts Inst. of Technology.

An empirical relationship has been found to exist between rupture life and minimum (secondary) creep rate for a large number of alloys. This relationship should enable one to estimate the rupture life once the minimum creep rate has been determined for a particular creep rupture test. The effects of such variables as testing stress, temperature, composition, and total ductility were investigated for their effects on the empirical relationship.

(Continued in Thirteenth and Sixteenth Sessions)

The Effects of Strain Rate and Temperature on the Stress-Strain Relations of Deep-Drawing Steel. R. J. McDonald, R. L. Carlson, Battelle Memorial Institute, and W. T. Lankford, U. S. Steel Corp.

This paper discusses the effects produced by a range of strain rates (0.002 second^{-1} to 0.8 second^{-1}) and temperatures (75 to 300 F) on the stress-strain properties of fully aluminum-killed, temper-rolled steel. In presenting the data, special attention is given to the yield-point phenomena and the work-hardening characteristics accompanying plastic deformation. It is shown that the yield-point phenomena, which generally are absent with fully aluminum-killed, temper-rolled steel, occur with considerable intensity at high rates of strain.

Monday, June 18 8:00 p.m. Third Session

Held simultaneously with the Second and Fourth Sessions

Concrete Session

Effect of Revibration on Properties of Portland Cement Concrete. D. H. Sawyer and S. F. Lee, Dept. of Highways of Kentucky.

The investigation was designed to show the effects of delayed vibration on physical properties of concrete. Studies were made to determine the variations in the physical properties of concrete vibrated at 45-min intervals over an 8-hr period. Vibration of specimens in excess of a 4.5-hr period was permitted by use of a retarding additive. Concrete properties, with and without air entrainment, were compared at the various revibration periods. Comparisons were also made to strengths obtained from the standard methods of making and curing laboratory specimens.

These tests indicated that significant variations in concrete strengths, durability, and permeability are effected through the disturbance of the initial setting process of the cement.

A Statistical Study of Flexural Strength of Concrete Beams. William C. Otto, Bureau of Yards and Docks.

Using *STP 15-C*, prepared by ASTM Committee E-11, as a guide, a statistical study of the flexural strength data for concrete beams from eight separate naval airfield paving projects has been made. The data include tests of approximately 1000 concrete beams.

By using computed standard deviations and the normal law integral diagram, cumulative frequency curves were plotted. Analysis of these data indicates the desirability of including two minimum requirements in project specifications; a minimum average flexural strength at 28 days for a group of three or more beams and a minimum individual value within a group.

The mean values for ratios of 7 to 28 days flexural strength were obtained both for all individual beams and for all groups of beams for each project. The standard deviations of these ratios were also computed.

The coefficients of variation for flexural strength and compressive strength data are compared. Results thus far obtained, indicate that the two sets of computed values are of nearly the same order of magnitude.

A Comparison of the Durability of Six Concretes as Measured by the Four ASTM Freezing-and-Thawing Methods. H. T. Arni, B. E. Foster, R. A. Clevenger, National Bureau of Standards.

A description of automatic apparatus used to operate simultaneously all four of the ASTM tentative methods of test for resistance of concrete specimens to freezing and thawing is given. Details of the development and operation of the apparatus are given together with the problems dealt with in meeting the specification requirements. Time-temperature curves obtained with thermocouples imbedded in specimens illustrate the operation of each of the four methods. Data obtained from tests on six concretes made from three different aggregates and with two amounts of entrained air are given. Confidence intervals are plotted to show which methods best separate the different concretes as well as how many cycles of test are required to give a reliable separation between these concretes.

Correlation of Sonic Properties of Concrete with Creep and Relaxation. Tien S. Chang and Clyde E. Kesler, University of Illinois.

This paper presents a method of relating the properties of concrete that can be determined from sonic testing to the creep and relaxation of concrete in axial compression. Valid nonlinear mechanical (rheological) models are selected to represent the concrete in creep and relaxation. The coefficients of these models are statistically related to ultimate strength, sustained stress, and the sonic properties of concrete. A simple procedure is also developed to relate the creep deflection of one concrete beam to another under a different loading condition provided the beams are loaded to less than 50 per cent of their maximum load-carrying capacity.

The results presented in this paper provide a means of predicting the creep and relaxation behavior of concrete from a relatively simple laboratory nondestructive test.

Use of Fly Ash in Concrete. Albert G. Timms and William E. Grieb, Bureau of Public Roads.

The purpose of this investigation was to study the properties of concrete containing four fly ashes as replacement for part of the portland cement. These were selected from two different sections of the country where there are wide differences in the characteristics of the coal used for fuel. From each source fly ashes of widely different fineness were selected, with the expectation that those with the maximum fineness would have the lowest carbon content. Concrete specimens containing the fly ashes were tested for strength at various ages, for shrinkage at various periods when stored in a dry atmosphere, durability in freezing and thawing and resistance to attack of calcium chloride used for ice removal. These tests indicate, in general that at ages through 28 days both the flexural and compressive strengths were lower than comparable concrete without fly ash. At 1 yr the strengths of the concrete containing fly ash were about as high or higher than the plain concrete. Fly ash did not improve the resistance of freezing and thawing of non-air-entrained concrete. In air-entrained concrete some of the fly ashes gave satisfactory durability and some did not. The particular portland cement used was also a factor. In general, concrete containing fly ash showed less shrinkage upon drying than concrete without fly ash. All substitutions of fly ash for portland cement adversely affected the resistance of both air-entrained and nonair-entrained concrete to attack by calcium chloride solutions used for ice removal.

Studies Relating to the Testing of Fly Ash for Use in Concrete. R. H. Brink and W. J. Halstead, Bureau of Public Roads.

Recent interest in the use of fly ash in concrete for highways has created a need for suitable specifications and methods of test for this material. In this study, consideration is given to the testing of fly ash to indicate its probable effect on the strength of concrete. To determine the variations in properties which may be expected and the effect of these variations on the behavior of the fly ash in concrete, 33 fly ashes from 19 different sources were examined.

The results of the tests made indicate that generally the strength developed in portland cement-fly ash mortars is related to the carbon content of the fly ash, the fineness as measured by the amount passing the No. 325 sieve, and the water required for mortars containing fly ash as compared to the water required for similar mortars without fly ash. No well-defined relationship between the individual inorganic constitutents of the fly ash and the development of strength in the mortar was obtained.

The tests also indicate that the strength developed by pozzolanic action in a cement-fly ash mortar varies for different cements, some cements giving much better results than others.

In addition to the studies of strength development, tests of mortar bars show that fly ash may be used to inhibit the expansion resulting from the alkali-aggregate reaction. These tests indicate that the amount of fly ash required to reduce expansion below a safe limit varies for different fly ashes.

Monday, June 18 8:00 p.m. Fourth Session

Held simultaneously with the Second and Third Sessions

Symposium on Ion-Exchange and Chromatography in Analytical Chemistry

This symposium is sponsored by ASTM Committee E-3 on Chemical Analysis of Metals. Division G of this committee (H. F. Beeghly, chairman) constitutes the Symposium Committee. The 1956 symposium is expected to be the first in an annual series of symposia sponsored by Committee E-3 on timely subjects of importance to ASTM members concerned with analysis of materials. They are being planned to acquaint ASTM members with new methods, techniques, etc., which are actually or potentially capable of use in standard methods of analysis.

The 1956 Symposium is intended to present a picture of the materials available, or under development, for ion-exchange and chromatography, the basic theory of their use, and examples of their application for separation and analysis of materials. Primary emphasis will be on metals but data of value to people concerned with other materials will be included.

The Use of Ion-Exchange Resins in Analytical Chemistry. Robert Kunin, Rohm and Haas Co.

The use of ion-exchange techniques and ion-exchange resins in the various fields of analytical chemistry have been developed to the stage where they are no longer considered as research curiosities but are now employed routinely in most research and control laboratories. Ion-exchange resins are employed routinely for the analysis of water samples, minerals, metals, and various solutions of electrolytes.

The wide choice of available resin type and the high capacity and durability of these ion-exchange materials have contributed materially to the acceptance of this technique.

These techniques are particularly useful for (1) concentrating a trace constituent, (2) removing an interfering element, (3) determining total concentrations, (4) purifying reagents, and (5) dissolving insoluble samples.

The Use of Ion-Exchange Techniques in Analytical Chemistry and Radiochemistry. J. E. Hudgens, Atomic Power Division, Westinghouse Electric Corp.

A number of ion-exchange methods for the separation and identification of both cationic and anionic fission elements have been developed. The total weight of many of these elements normally associated with materials which have undergone neutron bombardments enables a good test of the laws governing ideal solutions and the extension of the data to the concentration ranges normally encountered in ordinary analytical chemistry. The ion-exchange column required for many of the separations contains less than 2 ml of resin and the volume of eluent was therefore minimized. Several samples of separations which have been useful in radiochemistry and analytical chemistry are given.

Anion-Exchange in Metal Separations. Kurt Kraus, Oak Ridge National Laboratory.

Separation of metals by ion-exchange may in principle be achieved by two techniques: cation exchange which operates on the positively charged metal ions, and anion exchange which operates on negatively charged complexes. It appears that for many many purposes the anion exchange technique is the more superior separations tool, principally since commercial organic anion exchange resins have striking selectivity for some complexes and since extensive complexing often accentuates differences between elements. Further, the anion exchange method has considerably greater flexibility and broader applicability than the cation exchange method. In fact, except for the heaviest alkali metals, all metallic elements may be absorbed on anion exchangers and most of these may rapidly, and often uniquely be separated from each other.

Ion-Exchange in the Analysis of Metals. John L. Hague, National Bureau of Standards.

Ion-exchange separation is one of the relatively new techniques useful in the analysis of metals. The choice of a chemical reaction and resin largely determine the success or failure of a quantitative separation. Factors influencing the selection of a chemical reaction and resin type are discussed from the viewpoint of applied analysis with typical examples of some of the types of available procedures.

Anion separations are particularly useful in the usually difficult separations encountered within the conventional analytical subgroups. The application of this type of separation to the analysis of a typical high-temperature alloy will be demonstrated by the use of color slides.

Tuesday, June 19 9:30 a.m. Fifth Session

Held simultaneously with the Sixth Session

Symposium on Solder

Industrial Survey of Paste Solder Alloys H. R. Williams, Fusion Engineering.

Design Considerations for Soft Soldered Joints. Alfred Johns, Eastman Kodak Co.

Quality Control Procedures in the Soft Soldering of Electronic Equipment. W. H. Rombach, Philco Corp.

Solders, Fluxes and Techniques for Soldering Aluminum. J. D. Dowd, Aluminum Co. of America.

Aluminum can be soldered by any of the common methods such as torch, iron, dip, furnace, and induction soldering, and also by several methods more applicable to aluminum than to other metals such as rub, ultrasonic, and reaction-flux soldering. For some applications, it may be desirable to plate the aluminum with copper, nickel, or some other metal and then solder using procedures applicable to the plating metal. The soldering method to be employed will depend largely upon the shape of the parts, design of the joints, performance requirements of the soldered assembly, and the economics of the various methods. The solders for aluminum are usually alloys of zinc, tin, cadmium, and lead, although small amounts of other elements have been added to many such solders. In general, solder wetting, fillet size, joint strength, and corrosion resistance increase with increasing zinc content of the solder.

Before soldering aluminum, the oxide film on the surface must be removed, either mechanically while the surface is covered with molten solder, or with fluxes. Chloride-free organic fluxes are recommended when soldering with low-temperature solders. Chloride-containing salt fluxes must be used, however, when soldering with intermediate- and high-temperature solders. The resistance to corrosion of soldered joints in aluminum varies greatly, depending upon the solder composition, joint design, use of protective coatings, and the environment in which the soldered joints are exposed.

Corrosive Fluxes—Their Role in Soldering R. M. McIntosh, Tin Research Institute Inc.

(Continued in Ninth, Fourteenth, and Fifteenth Sessions)

Tuesday, June 19 9:30 a.m. Sixth Session

Held simultaneously with the Fifth Session

Symposium on pH Measurement

In the ten years that have elapsed since the first Symposium on pH Measurement was held at the ASTM 49th Annual Meeting in Buffalo, N. Y., pH instrumentation and technology have continued their rapid development. To keep pace with the expanding application of pH measurements, an operational definition of the pH value has been accepted despite the risk of robbing pH measurements of a good part of their fundamental meaning. To preserve as much of the quantitative significance as possible, a proper understanding of the methods of standardization and the techniques of measurement is essential. Although pH measurements are now easily made in many nonaqueous and partly aqueous media, their interpretation is much less certain than in water. There is likewise considerable doubt as to whether pH is the most useful expression of acid-base relationships in diverse media. It is the purpose of this second Symposium on pH Measurement to consider the new developments in pH and to clarify the problems they have created.

Introduction. E. B. Ashcraft, Westinghouse Research Laboratories.

Meaning and Standardization of pH Measurements. Roger G. Bates, National Bureau of Standards.

The standardization of pH measurements

is complicated by the fact that the definitions of pH most satisfactory in theory are not well adapted to practical experimental determinations. Consequently, the pH unit lacks exact fundamental meaning and rests in part on an arbitrary, though reasonable and useful basis. The restrictions thus imposed on the pH measurement and the limitations to the meaning to experimental pH values in diverse media are indicated. The special problem of standardizing measurements at very low and very high pH is also considered. The preparation and properties of the NBS pH standards are described with a listing of their pH values from 0 to 95 C.

Performance Studies of pH Electrodes and Their Components at High Temperatures and Pressures. John E. Leonard, Beckman Instruments, Inc.

A brief review of the literature on pH measurements at high temperature and pressures is presented together with a discussion of the major problems involved in pH measurement under extreme conditions and an outline of the objectives of the present study, and the methods and apparatus used in making the measurements. The data include the measurement of the temperature coefficients of potential of silver-silver chloride and saturated calomel half-cells from room temperature to 125 C. Measurements are given of the useful life of these cells at various temperatures up to 125 C, and reasons postulated for their eventual failure. The problem of establishing stable liquid junctions under high pressure is considered.

Modern Developments in pH Instrumentation. W. R. Clark and G. A. Perley Leeds and Northrup Co.

The paper discusses the criteria which should be considered in designing a universal stabilized indicator suitable for precise measurement of pH by various types of electrodes. Different types of circuits used in measuring pH are described and their approach toward meeting the criteria of good performance. Circuits discussed are the single electrometer-tube type, the two-tube balanced-bridge arrangement, the direct-coupled d-c feedback amplifier, the d-c to a-c conversion electromechanical null-balance system used in recorders, and the circuit which uses d-c to a-c conversion, plus amplification, with a-c to d-c conversion to provide the stabilizing feedback voltage.

(Continued in Tenth Session)

Tuesday, June 19 11:30 a.m. Seventh Session

Committee Report Session

A-1 on Steel. H. B. Oatley, Chairman.

C-2 on Magnesium Oxychloride and Magnesium Oxysulfate Cements. D. S. Hubbell, Chairman.

C-3 on Chemical-Resistant Mortars. Beaumont Thomas, Chairman.

C-4 on Clay Pipe. J. C. Riedel, Chairman.

C-8 on Refractories. R. B. Sosman, Chairman.

E-5 on Fire Tests of Materials and Construction. A. L. Brown, Chairman.

E-6 on Methods of Testing Building Constructions. R. F. Legget.

The Effect of Weathering on Certain Mortars Exposed in Brick Masonry Having Several Degrees of Protection. J. W. McBurney, National Bureau of Standards.

Tuesday, June 19 12:00 noon Eighth Session

Luncheon Session—President's Address, 40- and 50-Year Members, Awards of Merit, Introduction of New Officers

Tuesday, June 19 2:30 p.m. Ninth Session

Held simultaneously with the Tenth Session

Symposium on Solder *(Continued)*

"Tin Disease" in Solder Type Alloys. Alfred Borneman, Stevens Institute of Technology.

This summarizes investigations made throughout a five-year period, at Stevens Institute of Technology, on (1) the effect of low-temperature storage on the tendency of various tin alloys to undergo transformation, and (2) the possibility of shortening the incubation period of the reaction so that investigations of this phenomenon might be expedited. Evidence is presented that small amounts of bismuth and antimony are effective, as additions to tin an tin-lead solder alloys, in preventing the transformation of the tin during storage at low temperatures, 32 F and below. It is proposed that a floor as well as a ceiling be fixed for these impurities in ASTM Specification B 32. Some observations on the occurrence, or nonoccurrence, of transformation in electroplated and hot-dipped coatings of tin and tin alloys are also included. Experiments are described which involved inoculation and strain as agents to accelerate the transformation of white to gray tin.

The Performance of Some Soft Solders at Elevated Temperatures and Pressures. H. E. Pattee and R. M. Evans, Battelle Memorial Institute.

A program to investigate the properties of some soft solders at moderately high temperatures and pressures was initiated to assist the automotive radiator designers and others who use or may have occasion to use soft solders under these conditions. The accumulation of such data is needed, since it is common knowledge that soft solders lose much of their strength at elevated temperatures.

A cyclic-loading apparatus, similar in operation to those used in industry to test radiators, provided a means of evaluating solders. The test specimen was a split brass capsule that was joined by a standardized soldering technique with the solder under test. Steam was cycled through the capsule six times per minute at varying temperatures and pressures until failure occurred.

Tests of common solders, including tin-lead solders of various compositions, high-tin solders, and high-lead solders, formed a basis on which the performance of solders whose compositions were altered by minor additions could be judged. The compositions of 15 Sn - 85 Pb, 30 Sn - 70 Pb, and 70 Sn - 30 Pb solders were modified by the addition of other constituents in an attempt to improve their performance at high temperatures. Cerium, for example, improved the performance of both 30 Sn - 70 Pb and 70 Sn - 30 Pb solders, but not to the same degree. Additions of nickel, manganese, germanium, tellurium, and chromium improved the performance of 70 Sn - 30 Pb solder; however, only the nickel and germanium additions had any beneficial effect on the performance of 30 Sn - 70 Pb solder.

Some work on the corrosion effects of antifreeze solutions and rust inhibitors on soldered joints was included in this program. The effects of joining brass materials with tin-lead solders containing various amounts of antimony were also studied briefly.

Solder Dipping of Printed Circuits. George W. Cavanaugh, General Electric Co.

This paper covers (1) the evolution of printed wiring in the electronic industry, (2) the soldering problems involved in each technique and their solutions, (3) the history of all the various fluxes used in an attempt to solve the solderability problem, (4) the effects of soldering temperatures on the adhesives used to hold the circuit to the laminated board, and (5) a study of some of the variables affecting reliability of joints such as (*a*) optimum hole sizes, (*b*) optimum component wire sizes, (*c*) best alloy to use, and (*d*) best temperature and time.

Creep, Fatigue and Vibration Resistance of Soft Soldered Joints. Eugene Miller, Naval Ordnance Div., Eastman Kodak Co.

Fluxes and Their Application in Soldering. A. Z. Mample, Western Union Telegraph Co.

(Continued in Fourteenth and Fifteenth Sessions)

Tuesday, June 19 2:30 p.m. Tenth Session

Held simultaneously with the Ninth Session

Symposium on pH Measurement (*Continued*)

Problems in Measurement of the pH of Blood and Other Biological Fluids. Julius Sendroy, Jr., Naval Medical Research Institute.

A consideration of problems more or less peculiar to the measurement of the pH of blood and other biological fluids must include the evaluation and control of various factors of operation and mensuration. Pertinent items to be considered are the methods of withdrawal, the preservation, and the storage of the sample; the separation of plasma and cells; variations in temperature; and possible chemical changes taking place in the sample itself, in the interim between withdrawal and pH determination. Systems and techniques of measurement and calibration are evaluated with a view to effecting the closest agreement between measured pH values and those existing *in vivo*.

Quantitative Applications of pH in Analytical Chemistry. Henry Freiser, University of Pittsburgh.

Apart from the increasingly general recognition of the pH meter as the most nearly universal indicator for acidimetric and alkalimetric determinations, there are a number of important analytical applications requiring reasonably accurate pH measurements. Two areas will be discussed:

1. Equilibrium and rate constants of reactions involving change in hydrogen ion activity can be evaluated. For example, by the determination of the titration curve of an unknown acidic or basic material it is possible to evaluate its ionization constant, a quantity that reveals much about the identity and structure of the titrated substance.

2. Microanalysis.—Measurement of pH is itself a micro or trace analysis. In a number of cases, the stoichiometry of micro scale reactions involving change in hydrogen ion activity can be successfully carried out by simply measuring pH changes.

Theoretical and Practical Problems in the Measurement of Acidity in Aqueous and Nonaqueous Media. Martin Kilpatrick, Illinois Institute of Technology.

In 1946 the author showed that for basic solvents of not too low dielectric constant the dissociation constant of an acid at infinite dilution [K_c]^0 is a measure of the relative acid strength in *each* solvent, the standard acid being the solvated proton and that the colorimetric method could be conveniently applied to nonaqueous solvents over a wide range of acid strengths. However, the problem of a general scale of acidity which applies from solvent to solvent remains with us.

The present paper discusses the theoretical aspects of this problem and reviews the assumptions which yield practical solutions.

Indicator Acidity Functions for Nonaqueous and Mixed Solvents. M. A. Paul, Harpur College, and F. A. Long, Cornell, University.

Indicator acidity functions are derived from measurements with indicators of specified charge types. The function H_0 derived from uncharged bases has received the most extensive development. It has been applied to several nonaqueous solvents and their mixtures with water as well as to concentrated aqueous solutions of various acids. In media of low dielectric constant, the indicators show greater specificity and the generality of the acidity-function concept needs further investigation.

Acidity scales derived from other types of indicators have also been described. In general these will not agree with each other outside the dilute aqueous solution. Indicator acidity functions apply directly to strength determinations for very weak acids and bases. Their major application has been to problems of acid catalysis, where they have been found to discriminate among different reaction mechanisms.

Tuesday, June 19 4:30 p.m. Eleventh Session

Committee Report Session

A-5 on Corrosion of Iron and Steel. A. P. Jahn, Chairman.

C-9 on Concrete and Concrete Aggregates. W. H. Price, Chairman.

C-13 on Concrete Pipe. R. R. Litehiser, Chairman.

C-15 on Manufactured Masonry Units. J. W. Whittemore, Chairman.

C-18 on Natural Building Stones. L. W. Currier, Chairman.

C-20 on Acoustical Materials. H. A. Leedy, Chairman.

E-11 on Quality Control of Materials. H. F. Dodge, Chairman.

Tuesday, June 19 5:00 p.m. Twelfth Session

Gillett Memorial Lecture

Structural Chemistry and Metallurgy of Copper. D. K. Crampton, Director of Research and Development, Chase Brass and Copper Co.

This Lecture, established in 1951, is jointly sponsored by ASTM with Battelle Memorial Institute. It commemorates Horace W. Gillett, one of America's leading technologists and metallurgists and the first Director of Battelle. The Lecture is delivered annually at a meeting of the Society, the first one having been given at the Fiftieth Anniversary Meeting, June, 1952. The Lecture will cover subjects pertaining to the development, testing, evaluation, and application of metals.

Tuesday, June 19 8:00 p.m. Thirteenth Session

Held simultaneously with Fourteenth Session

Metals Session

Correlation of Torsional and Tensile Prestrain Effects on Fracture Properties. I. Rozalsky, Shell Oil Co.

The object of this investigation was to make a correlation of the effects of room temperature tensile and torsional prestrain upon the tensile fracture properties of annealed, face-centered cubic copper and spheroidized, body-centered cubic SAE 1020 steel at various test temperatures from +75 F to −321 F.

Evidence of rheotropic behavior for the steel was found at subtransition test temperatures for both tensile and torsional prestrain. The helical "wolf-ear" tensile fracture obtained subsequent to critical magnitudes of torsional prestrain degenerated in appearance with decreasing supertransition test temperatures and essentially disappeared at subtransition test temperatures. Generalized prestrain equations were employed to show the interrelation between simple tensile and torsional prestrain and to correlate their effects upon the fracture properties in tension for the copper and steel.

Factors Affecting the Forming Properties of Several Copper Alloys in Strip Form. John T. Richards and Ellsworth M. Smith, Penn Precision Products, Inc.

Bend, tension, and hardness tests were performed on beryllium copper, phosphor bronze, brass, nickel silver, and chromium copper strip to determine relative forming characteristics. Formability is expressed as the minimum safe radius for cold forming a 90-deg bend. The effects of composition, temper, thickness, grain size, and grain direction are considered. This investigation supplements earlier work on the forming properties of spring materials.

The Effect of Irradiation on the Mechanical Properties of Zirconium. R. S. Kemper, Jr., and W. S. Kelly, General Electric Co.

Data are presented to show the effects of cold-working and subsequent neutron irradiation on the tensile properties and hardness of arc-melted Bureau of Mines zirconium. Material in six initial states: annealed and with 10, 20, 30, 40, and 50 per cent reduction

in area by cold swaging, was irradiated at 50–60 C (120–140 F) to integrated thermal flux levels of 5.7×10^{19}, 1.5×10^{20}, and 2.4×10^{20} *nvt*. The effects of post-irradiation vacuum annealing at 250, 300, and 350 C (480, 575, and 660 F) on the tensile properties are also shown.

The Effect of Brittle Skins on the Ductility of Metals. G. W. Form, Ecole Polytechnique Montreal, and W. M. Baldwin, Jr., Case Inst. of Technology.

Brittle skins (*e.g.*, carburized cases) embrittle an otherwise ductile metal to a greater degree than would be anticipated by the percentage of bulk that the skin occupies. Evidence is adduced to show that in tensile tests on metals with brittle skins, the skin cracks at a negligible strain, and that from this point on the test is merely a notch tensile test of the core. This points out, among other things, that notch-sensitive steels are ill-suited for carburizing purposes.

Notch Tensile Behavior of Face-Centered Cubic Metals. E. J. Ripling, Continental Can Co., Inc.

It is shown that the magnitude of transverse stresses developed in a notched tensile bar should depend on the rate at which the load-carrying capacity of the bar changes along a tapered length after the piece is strained. Hence, the notch sensitivity of metals should be a function of their strain-hardening exponents.

In order to determine whether or not this is the case, unnotched and notched tests were conducted on a variety of face-centered cubic metals. A material dependent parameter, which is a quantitative measure of notch sensitivity, is described from which notch ductility damage, and subsequently notch strength can be calculated.

Materials for Helical Compression Springs for Use at Constant Deflection from 600 to 1400 F. R. G. Matters, and R. E. Lochen, Allis Chalmers Manufacturing Co.

This paper presents data on relaxation behavior of helical compression springs made from high-speed steel, Inconel, 3 cold drawn austenitic steels and 4 precipitation hardenable alloys. High-speed steel and the more highly alloyed cold drawn austenitic steels had good properties up to about 900 F. For optimum resistance to relaxation springs formed from cold-drawn wires should be stress-relieved before service. The precipitation hardenable alloys may be useful for springs to operate up to 1200 F.

Tuesday, June 19 8:00 p.m. Fourteenth Session

Held simultaneously with Thirteenth Session

Symposium on Solder (*Continued*)

Factors in Successful Soldering, Clifford L. Barber, Kester Solder Co.

Solder may be called "the poor orphan of the literature", although it has been known and used for hundreds of years it has never gained the kind of acceptance in that ivory tower of scientific thought that normally attracts investigation and interest. As a consequence the basic facts of soldering which appear obvious or even axiomatic, are in reality little understood and appreciated.

This paper discusses the fundamentals that relate most specifically to the realities of successful industrial usage, including the general character of soldering technique, metal preparation for soldering, the role of heat, the application of flux core solder, and the practical problems of dip-pot soldering.

Ultrasonic Soldering of Aluminum. J. B. Jones and J. G. Thomas, Aeroprojects, Inc.

Ultrasonic techniques permit soldering of aluminum without the use of any fluxes whatsoever, with the elimination of corrosion attack resulting from flux residue or inadequate cleaning after soldering. Using these techniques, aluminum joints were fabricated with three binary solder alloys and two ternary alloys and were exposed to two corrosion media—hot aerated distilled water and salt water.

Data showing the decay of joint strength as a function of time of each solder in each environment are presented. Corrosion attack was observed to cause separation of the joints along the solder-aluminum interface. This localized penetration has been explained on the basis of a high galvanic potential at the interface resulting from the diffusion of solder constituents into the aluminum.

There are many applications for soldered aluminum assemblies where corrosion is not a factor or where selection of a suitable solder permits reasonable life in a corrosive environment. Ultrasonic equipment is available covering a broad range of applications from diminutive precise devices for silicon transistor connections to large units for continuous coating of metal strip materials.

Proposed Numerical Evaluation System for Soft Solders, Solder Fluxes, and Solderability. L. Pessel, Radio Corporation of America.

In the numerical evaluation system described in this paper, the nominal diameter of a sphere formed by a standardized solder specimen provides the 0 per cent mark, the infinite thinness of the same solder mass, spread as a film, the 100 per cent mark, on a percentage scale. Intermediate values are determined by measurement of the height or thickness of the solder spots, obtained after melting, by means of a hand micrometer. The empirical spread factor values thus obtained provide a simple, reproducible, visually significant, numerical system. Applications of this system for the evaluation of solders, fluxes, and metallic surfaces with respect to solderability are given.

(Continued in Fifteenth Session)

Review of Testing Methods and Summarization of Data. R. J. Nekervis, Tin Research Institute, Inc.

The Use of Rosin and Activated Rosin Fluxes. F. C. Disque, Jr., Alpha Metals, Inc.

This paper, following a brief review of the historical aspects of the use of rosin and activated rosin, discusses their nature and the mechanism of fluxing action. The problems of corrosion and conductivity of the flux residues are taken up along with some aspects of the measurement of these properties indicating the need for an intelligent appraisal of the effects of the flux residue on performance of modern electronic equipment.

Wednesday, June 20 9:30 a.m. Fifteenth Session

Held simultaneously with Sixteenth Session

Symposium on Solder (*Continued*)

Soldering in Semiconductor Devices. W. Lootens, General Electric Co.

Semiconductor devices are very sensitive to surface contamination and soldering flux is like a death warrant to the device. It is possible to do most of the soldering jobs on these devices without flux by using the correct materials, temperature, and atmosphere. Illustrations of examples of how this has been done are shown. Some of the requirements for various applications are given. Certain metals, if used on semiconductor materials, may give trouble, even if they occur only as an impurity in the solder. These metals are listed along with the effects they would produce.

Gray Tin Formation in Soldered Joints Stored at Low Temperature. W. Lee Williams, U. S. Naval Engineering Experiment Station.

A study was made of soldered joints to determine susceptibility to gray tin formation at low temperature. Copper joints were soldered with tin, high-purity tin-lead alloys, and commercial tin-lead alloys. The soldering time and temperature were varied to provide low and high copper contamination of the solder film. Impact, tension (sleeve-joint) and pressure-seal specimens were tested at room temperature, at −40 F, and at −40 F after 6½ months storage at −40 F. The cold-stored specimens were inoculated with gray tin to promote transformation. No deterioration was found in the commercial tin-lead solders. The pure tin-lead solders had minute traces of gray tin. The pure tin exhibited marked transformation which caused a significant loss of impact strength. Copper contamination of the solder film during the soldering operation did not appear to inhibit gray tin formation.

A Method for Testing and Evaluating the Joint Properties of a Copper Bushing Soldered to an Aluminum Casting. M. V. Davis, Anderson Brass Works, Inc.

Noncorrosive and Intermediate Fluxes. H. C. Sohl, American Smelting and Refining Co.

Wednesday, June 20 9:30 a.m. Sixteenth Session

Held simultaneously with Fifteenth Session

Metals Session

The Strength of Certain Stainless and Carbon Steels at Low Temperatures. S. C. Collins, and F. D. Ezechiel, Massachusetts Inst. of Technology, O. W. Sepp, U. S. Army Air Force, and J. W. Rizika, General Electric Co.

Preliminary results of torsion and tension tests of various steels at very low temperatures are reported. The tests are conducted in a stream of cold gaseous helium whose temperature can be adjusted to any value between 1 and 300 K. Unusual discontinuities in the stress-strain relationship of stainless steel at the lower temperatures are observed. The effect of work hardening at low temperature upon the room-temperature strength is also noted.

Creep-Rupture Properties of Some Cast and Wrought 12 per cent Chromium Steels. Paul Shahinian, Naval Research Laboratory, and Joseph R. Lane, National Academy of Science

An investigation was made of the creep-rupture properties of 12 per cent chromium steels modified by additions of molybdenum, vanadium, columbium, titanium, and carbon. The modifications were evaluated in the cast and homogenized and also in the forged normalized and tempered conditions for possible service in the temperature range of 1100–1200 F.

The high-temperature strength of base compositions was improved by an increase in molybdenum and lowered by increases in carbon, vanadium, and titanium; columbium did not produce a consistent effect. The wrought steels ranked only slightly differently, in order of merit, from the cast steels. In general, with the heat treatments used in this study, the cast alloys were stronger than the wrought alloys.

Effect of Composition and Heat Treatment upon the Impact Properties of AISI Types 403 and 410 Stainless Steel. E. J. Whittenberger, E. R. Rosenow, and D. J. Carney, U. S. Steel Corp.

The use of higher carbon contents (0.12 to 0.19 per cent), the addition of nitride and carbide forming elements (Al, V and Ti), and austenitizing at lower temperatures to achieve finer grain size and minimize intergranular carbide precipitation during subsequent tempering were all found to improve the impact properties of the 12 per cent chromium steels investigated. Increasing amounts of manganese, nickel and nitrogen did not appear to increase the impact strength.

Effect of Structure on Creep at High Temperatures. O. D. Sherby, T. A. Trozera, and J. E. Dorn, University of California.

Structural changes attending creep at high temperatures and high stresses are dependent on the preceding creep-stress history. Results on aluminum solid solution alloys indicate that initial plastic straining upon application of a constant stress decreases the creep resistance whereas the straining during creep increases the creep resistance. At low stresses the structural changes important to creep are minor. Neglecting transients that were observed upon change of stress, high-temperature creep at low stresses obeys a mechanical equation of state.

Notch and Smooth Bar Stress Rupture Characteristics of Several High-Strength, Heat-Resisting Alloys in the Temperature Range Between 600 and 1000 F. J. G. Sessler, Syracuse University, and W. F. Brown, Jr., NACA-Lewis Flight Propulsion Lab.

The paper presents notch and smooth stress-rupture data for SAE 4340, AMS 5616, 17-22A(S), AISI 410, 17-4PH, A286, and Inconel X directly determined in the temperature range between 600 and 1000 F. In addition, the use of the linear time-temperature parameter is demonstrated in obtaining high-stress, low-temperature data with a minimum number of tests.

The factors affecting the moderately elevated temperature rupture strength of the heat-resisting steels are discussed and experimental evidence presented showing the influence of heat treatment on both strength and notch sensitivity.

Autographic Bearing Strength Test Method and Typical Test Values on Some Magnesium Alloys at Room and Elevated Temperatures. James A. Gusack and A. A. Moore, Dow Chemical Co.

An autographic method of bearing yield strength determination is presented. It may be used for room temperature testing but is especially valuable in making high temperature bearing tests. Such test factors as edge distance, width and thickness of specimen, and hole diameter are discussed. Short time tensile test data and bearing test data are given for temperatures up to 600 F for some magnesium base alloys.

Wednesday, June 20 11:30 a.m. Seventeenth Session

Committee Report Session

C-14 on Glass and Glass Products. L. G. Ghering, Chairman.

C-16 on Thermal Insulating Materials. E. R. Queer, Chairman.

C-21 on Ceramic Whiteware and Similar Products. C. J. Koenig, Chairman.

C-22 on Porcelain Enamel. W. N. Harrison, Chairman.

D-4 on Road and Paving Materials. C. W. Allen, Chairman.

D-5 on Coal and Coke. W. W. Anderson, Chairman.

D-20 on Plastics. R. K. Witt, Chairman.

Wednesday, June 20 2:00 p.m. Eighteenth Session

Symposium on Tension Testing of Non-Metallic Materials

One of the simplest physical tests which can be made on any material, is, at first glance, a measure of the tensile pull required to break it. Perhaps it is in part this simplicity, both of concept and of execution, which has made tensile properties a common denominator in material testing, especially in the field of metals.

Among the non-metallic materials, however, there is such a diversity of structure and properties, that there has evolved a variety of methods for measurement of tensile properties. At least 60 such are listed in our ASTM Index. New materials have been developed for which older techniques are inadequate, new technical tools have been applied to the problem, new understanding of the structure of materials has brought a more meaningful interpretation of results and each of these factors has contributed to the terminology and nomenclature of tension testing.

Subcommittee 4, of E-1, on Tension Testing, has arranged this symposium with the objective of providing:

1. An accurate summary of present practices in fields where tension testing is most widely used.
2. A critical appraisal of their merits and deficiencies.
3. An opportunity to compare techniques and terminology among the various fields.
4. A guide to future development and standardization.

Present Practices in Tensile-Strength Testing of Paper in Industry. John Fachet and F. T. P. Plimpton, Jr., Thwing-Albert Instrument Co.

The subject of tensile-strength testing of paper and paperboard is introduced by showing its importance in production and quality control.

The functioning of a tensile-strength test is discussed covering the types of tensile-strength testers and the controlling factors in the measurement of the tensile strength of paper.

Various types of papers are discussed in relation to tensile-strength testing with note of special fixtures or grips utilized.

The conclusion covers the general meaning of the tensile-strength test to the paper industry with notes on possible areas for improvement in testing.

Tension Testing of Adhesives. A. G. H. Dietz, Massachusetts Inst. of Technology.

Tension testing and tensile strength of adhesives are profoundly affected by the characteristics of both adhesive and adherent. Geometry of the specimen, treatment of the adherent surface, thickness of the glue line, and environment all play a part. Discussion will first include an examination of these factors and will then proceed to various types of test procedures and specimens, including vibrational as well as static techniques. Some results obtained with the various methods will be included.

Tensile Load-Deformation Testing of Textile Structures, Stanley Backer, Massachusetts Inst. of Technology.

A survey of instruments used for tension testing of textile structures, with consideration given to loading rates, measurement and recording techniques, and special accessories. Sample preparation techniques are discussed and machine-specimen interactions analyzed. Important variables in textile testing are described and areas for future textile testing outlined.

Tension Testing of Rubber. H. Tagenberg, B. F. Goodrich Co.

The methods for the tension testing of soft rubber vulcanizates are reviewed for comparison with those of other non-metallic materials. The methods reflect the mature consideration of many men who have worked with this unique material of high elongation and moderate strength. Not only does the unvulcanized material have a grain but its cured properties will be affected by mechanical working and humidity. Moreover, the vulcanized specimen is moderately sensitive to size and shape and to the temperature of testing. Fine discontinuities caused by a rough die or small lumps on the cut surface of the dumbbell lower the strength appreciably. The test machines are generally of the pendulum type with provisions for wide jaw separation, but recently other load-measuring devices are becoming available. The many details of preparation and testing must be controlled by the careful application of standard methods to minimize test errors on a practical basis.

Tension-Testing of Plastics. Frank W. Reinhart, National Bureau of Standards.

Tension-Test Methods for Wood, Wood-Base Materials and Sandwich Constructions. L. J. Markwardt and W. G. Youngquist, Forest Products Laboratory.

The paper points out the special problems encountered in developing tension tests for wood, which can be treated as an orthotropic material with three principal axes of symmetry. The assumption of three structural axes results in three tension properties varying 40 to 1, together with three Young's moduli varying as much as 150 to 1, three shear moduli varying 20 to 1, and six Poisson's ratio varying 40 to 1. Included is a review of the various types of tension tests required for evaluating the strength of wood along and across the grain, together with tension-test methods for veneer and plywood, for wood-base materials (such as fiberboard, in the machine and across-machine directions, and normal to the faces) and for sandwich constructions. Presented also is a summary of the progressive developments in arriving at presently standardized methods, with supporting data. The status of present standards with respect to their suitability and efficiency is reviewed, and recommendations are made as to further research required to improve certain types of tension tests for wood.

Report E-1 on Methods of Testing. J. R. Townsend, Chairman.

Wednesday, June 20 4:00 p.m. Nineteenth Session

Committee Report Session

A-7 on Malleable-Iron Castings. W. A. Kennedy, Chairman.

A-9 on Ferro-Alloys. W. C. Bowden, Jr., Chairman.

B-2 on Non-Ferrous Metals and Alloys. Bruce W. Gonser, Chairman.

B-6 on Die-Cast Metals and Alloys. W. Babington, Chairman.

D-1 on Paint, Varnish, Lacquer and Related Products. W. T. Pearce, Chairman.

D-13 on Textile Materials. W. D. Appel, Chairman.

D-16 on Industrial Aromatic Hydrocarbons and Related Materials. D. F. Gould, Chairman.

E-3 on Chemical Analysis of Metals. Arba Thomas, Chairman.

E-4 on Metallography. L. L. Wyman, Chairman.

E-12 on Appearance. M. Rea Paul, Chairman.

Wednesday, June 20 4:30 p.m. Twentieth Session

Marburg Lecture

The Industrial Chemistry, Properties, and Applications of Silicones. C. E. Reed, General Manager, Silicone Products Dept., General Electric Co.

The purpose of the Edgar Marburg Lecture is to have described at the annual meetings of the Society, by leaders in their respective fields, outstanding developments in the promotion of knowledge of engineering materials. Established as a means of emphasizing the importance of the function of the Society of promoting knowledge of materials, the Lecture honors and perpetuates the memory of Edgar Marburg, first Secretary of the Society, who placed its work on a firm foundation and through his development of the technical programs brought wide recognition to the Society as a forum for the discussion of properties and tests of engineering materials. Further details on page 5.

Wednesday, June 20

Cocktail Party 6:30 p.m.

ANNUAL DINNER 7:30 p.m.

Entertainment

Thursday, June 21 9:30 a.m. Twenty-First Session

Fatigue Session

Fatigue Properties of Comparable Cast and Wrought Steel. C. W. Briggs, Steel Founders' Society of America, L. J. Ebert, and E. B. Evans, Case Institute of Technology.

The fatigue properties of comparable cast and wrought carbon and low-alloy steels were determined by employing R. R. Moore test specimens. Each cast steel was studied at the same tensile-strength level as the comparable wrought steel.

This research program, which encompassed a five-year program of fatigue testing, was divided into these four main phases covering common factors which might influence the fatigue performance of carbon and low-alloy steels in the 0.30 to 0.40 per cent carbon range: (1) The effect of steel composition and heat treatment, (2) the effect of various surface finishes, (3) the effect of directionality in wrought steels, and (4) the effect of section size and location within a given section size.

The fatigue tests were performed with small standard notched and unnotched laboratory fatigue specimens in rotary bending.

Effect of Change in Cyclic Modulus on the Bending Fatigue Strength of Mild Steel. A. A. Blatherwick and B. J. Lazan, University of Minnesota.

Using a newly developed reversed-flexure machine, in which the stroke may be varied while the test is in progress, the actual behavior of the bending moment, stress, and strain is observed during fatigue tests. Two types of tapered specimens of mild steel are used. One has a solid circular cross-section while the other is hollow. These two specimen types permit an examination of the shape effect as it is influenced by the changing cyclic modulus. By varying the loading conditions, the influence of type of test on fatigue strength is observed. The results of the reversed-flexure fatigue tests under constant stress and constant moment are compared with axial-stress results.

E-9 on Fatigue. R. E. Peterson, Chairman.

Analysis of the Effect of Changing Modulus under Fatigue Conditions on Bending Stress Distribution. A. A. Blatherwick and B. J. Lazan, University of Minnesota.

The effect of a changing cyclic modulus on bending-stress distribution during fatigue tests is studied by means of assumed material behavior. Cyclic stress-strain curves consisting of two straight-line segments, in which the slope of the plastic leg varies with repeated cycles, are used to analyze the variation of stress, strain, and bending moment under various loading conditions. Two types of material are considered. One type exhibits strain-hardening characteristics under cyclic stress, while the other displays initially strain-softening properties. Various shapes of cross-section are considered in order that the shape effect might be examined in the light of the changing modulus. From this analysis comparisons are made between the fatigue strengths to be expected from tests under constant-strain, constant-stress, and constant-moment amplitudes.

Fatigue Crack Propagation in Aluminum Alloys. M. S. Hunter and W. G. Fricke, Jr., Aluminum Company of America.

(Continued in Twenty-Third Session)

Metallographic observation of fatigue cracks in aluminum alloys from their inception to final, complete failure of the specimen has revealed the manner in which fatigue cracks form and propagate and the effect of certain microstructural features on the rate and mode of crack propagation. It has been found that the length of a fatigue crack is related exponentially to the number of stress cycles and that the rate of propagation bears a similar relationship to the stress level. It has been observed that incipient fatigue cracks will propagate at stresses below the endurance limit and at rates which are simple extrapolations of those observed above the endurance limit.

Thursday, June 21 11:30 a.m. Twenty-Second Session

Committee Report Session

C-12 on Mortars for Unit Masonry. R. E. Copeland, Chairman.

C-19 on Structural Sandwich Constructions. E. W. Kuenzi, Chairman.

D-7 on Wood. L. J. Markwardt, Chairman.

D-12 on Soaps and Other Detergents. J. C. Harris, Chairman.

D-14 on Adhesives. R. F. Blomquist, Chairman.

D-21 on Wax Polishes and Related Material. W. W. Walton, Chairman.

D-22 on Methods of Atmospheric Sampling and Analysis. L. C. McCabe, Chairman.

D-23 on Cellulose and Cellulose Derivatives. F. A. Simmonds, Chairman.

E-10 on Radioactive Isotopes. G. D. Calkins, Chairman.

Thursday, June 21 2:00 p.m. Twenty-Third Session

Held simultaneously with Twenty-Fourth Session

Fatigue Session *(Continued)*

Strengths and Failure Characteristics of AMS 5534A (S-816) Alloy in Direct Tensile Fatigue at Elevated Temperatures. Charles A. Hoffman, NACA-Lewis Flight Propulsion Laboratory.

The direct tensile fatigue behavior of wrought AMS 5534A (S-816) alloy at 1200, 1500, and 1600 F was investigated. At each temperature 3 mean stress levels were selected to give stress-rupture lives of approximately 10, 100, and 1000 hr. Cyclic stresses in the range of 3 to 98 per cent were superimposed at each condition of mean stress and temperature.

The macroscopic appearance of the specimens at failure (*i.e.*, fracture surface, ductility etc.) was related to temperature, stress condition, and failure time. This was done to provide an aid in the interpretation of the role of vibratory stress in affecting service blade life.

Metallographic studies were conducted to provide insight into the relations between temperature, stress condition, and fracture path.

Statistical Analysis of Fatigue Data. R. Roeloffs and F. Garofalo, United States Steel Corp.

A summary of the statistical methods used successfully in recent years is divided into four different sections including: (1) variability in fatigue life at a fixed stress level, (2) variability in endurance limit among nominally identical specimens, (3) empirical fitting of *S-N* curves, and (4) fundamental theories of fatigue failures.

An "up-and-down" statistical method which has not been used extensively for measuring the fatigue limit and initial results on a manganese-molybdenum steel using this method are given.

An Evaluation of Statistical Treatments of Fatigue Data. M. N. Torrey and G. R. Gohn, Bell Telephone Laboratories.

This paper summarizes the results of reversed-bending fatigue tests on two lots of commercial grade A (5 per cent tin) phosphor bronze strip and presents the observed values (48 values for each deflection level) so that others may use them for further statistical analysis. The distributions of cycle life are fitted by logarithmic-normal, extreme value and log-log-normal distributions, showing that the type of distribution depends on the deflection (stress) value. The use of response curves is suggested.

A Wire-Fatigue Machine for Investigation of the Influence of Complex Stress Histories. H. T. Corten, and G. M. Sinclair, University of Illinois.

A wire-fatigue testing machine operating on the principle of a deflected rotating strut, was designed to investigate fatigue life for complex stress histories, particularly those consisting of repeated blocks of cycles. With this wire machine the stress amplitude may be changed rapidly from one level to another without inducing noticeable vibration in the wire specimen. For a comparative study of material behavior, wire-fatigue testing incorporates several particularly desirable features, namely inexpensive specimens and small scatter of data. The results of constant stress amplitude tests of steel wire are presented and analyzed statistically.

Thursday, June 21 2:00 p.m. Twenty-Fourth Session

Held simultaneously with Twenty-Third Session

Heat-Resistant and Corrosion-Resistant Alloy Session

Report of Committee A-10 on Iron-Chromium, Iron-Chromium-Nickel, and Related Alloys. Jerome Strauss, Chairman.

Report of Committee on Effect of Temperature on the Properties of Metals. F. B. Foley, Chairman.

Report of Advisory Committee on Corrosion. Jerome Strauss, Chairman.

The Corrosion Properties of Chromium-Nickel-Manganese Austenitic Stainless Steels. W. G. Renshaw and R. A. Lula, Allegheny Ludlum Steel Corp.

This paper deals with the corrosion properties of the Cr-Ni-Mn steels, AISI 201 and 202 and also some lower carbon and higher chromium grades. The influence of individual elements, chromium, nickel, manganese has been investigated. Chromium content has a significant influence on general corrosion resistance, as shown by improvement of nitric acid resistance with increasing chromium to 20 per cent. Nickel provides an additional improvement in resistance to general corrosion, and is especially effective in promoting resistance to localized attack. Manganese exerts relatively little influence through the range 3 to 14 per cent.

Resistance of these steels to intergranular corrosion, like that of chromium-nickel steels, in the sensitized condition, can be increased by decreasing carbon content. Carbon is somewhat less critical in Cr-Ni-Mn steels and resistance to intergranular corrosion after short-time sensitization is better than that of a Cr-Ni steel of the same carbon content.

Fretting Wear of Zircaloy-2 Pellets in High Temperature Water. L. A. Waldman and P. Cohen, Westinghouse Electric Corp.

Intergranular Corrosion Resistance of Low-Carbon Austenitic Chromium-Manganese-Nickel Steels. W. O. Binder, J. T. Thompson, and C. R. Bishop, Electro Metallurgical Co.

The Mechanical Properties of Type 201 Chromium-Nickel Manganese Stainless Sheet. R. A. Walsh, R. L. Cook, and R. A. Lula, Allegheny Ludlum Steel Corp.

The tensile and compressive properties were determined for two commercial heats of type 201 sheet with cold reductions from 0 per cent to 60 per cent. The tension tests were made on standard specimens taken parallel and perpendicular to the cold-rolling direction. The compressive tests were made using the Montgomery-Templin Compression Jig.

The influence of stress-relieving heat treatments at 600 and 800 F was determined for both tensile and compressive properties.

The results are presented as ultimate tension tests, 0.2 per cent offset yield strength elongation, moduli of elasticity and stress-strain curves. These data could be used for design in structures where type 201 is expected to find an increased field application.

Thursday, June 21 4:30 p.m. Twenty-Fifth Session

Committee Report Session

B-1 on Wires for Electrical Conductors. D. Halloran, Chairman.

B-3 on Corrosion of Non-Ferrous Metals and Alloys. K. G. Kompton, Chairman.

B-4 on Metallic Materials for Electrical Heating, Electrical Resistance, and Electrical Contacts. E. I. Shobert II, Chairman.

B-5 on Copper and Copper Alloys, Cast and Wrought. G. H. Harnden, Chairman.

B-7 on Light Metals and Alloys, Cast and Wrought. I. V. Williams, Chairman.

B-8 on Electrodeposited Metallic Coatings. C. H. Sample, Chairman.

B-9 on Metal Powders and Metal Powder Products. J. L. Bonanno, Chairman.

C-1 on Cement. R. R. Litehiser, Chairman.

D-17 on Naval Stores. V. E. Grotlisch, Chairman.

Thursday, June 21 8:00 p.m. Twenty-Sixth Session

Held simultaneously with the Twenty-Seventh and Twenty-Eighth Sessions

Symposium on Steam Quality

The 1941 symposium on steam quality marked the transition from determining the moisture in steam by measuring the temperature drop and reporting it in terms of percentage, to the determination of parts per million contamination and measuring it by conductivity instruments. Conductivity measurements with necessary corrections for dissolved gases had given most of the answers needed. With the introduction of higher pressures and higher steam temperature which resulted in the vaporization of dissolved solids in the boiler water, the need for a more sensitive and accurate measurement has been noted. Also the introduction of the once-through and the supercritical pressure boilers make obsolete the present methods for determining steam quality.

The purpose of this symposium is to review present practices and introduce new techniques that will aid in obtaining the answer that is needed for the determination of steam purity in modern steam generators. The new techniques should give a more accurate picture of the solids that are vaporized as well as the solids that are carried over by mechanical means.

Measurement and Purification of Steam to 0.01 ppm Total Dissolved Solids. W. B. Gurney, Gulf States Utilities Co.

Saturated steam above 500 psia, when expanded at constant heat to a slightly lower pressure, creates finite moisture. Separation of this moisture is readily accomplished in conventional equipment. The method is very efficient in removing solids, including silica, from saturated steam in boilers. The solids in the feedwater need not be low.

The removed solids, when analyzed, can show 0.01 ppm solids in the steam.

The method also indicates that present conductivity measurements of condensed steam to determine steam purity are practically meaningless for modern high-pressure boilers. Patent allowed.

Steam Purity Determination by Tracer Techniques. E. E. Coulter and T. M. Campbell, Jr., The Babcock & Wilcox Co.

This paper describes experiences in the use of phosphate (P^{32}), a radioactive isotope, and sodium as tracer materials for the determination of steam purity.

Included in the paper are the techniques employed and the results of laboratory tests using the radioactive isotope, in addition to the results of laboratory and field tests using sodium as a tracer material, for a comparison with the standard electrical conductivity method.

The results of this investigation bring forth the apparent extreme sensitivity of these materials, as compared to conductivity, in determining steam purity. The radioactive tracer is limited by economics to laboratory use. However the sodium tracer appears to possess the potential of a more accurate method to determine steam purity in industrial boiler plants.

Comments on Corrections to Steam Conductivity Measurements. R. O. Parker, R. J. Ziobro, Griscom Russell Co.

Published conductivity correction curves for carbon dioxide and ammonia disagree. A new curve, based on stated equilibrium constants and ionic conductances, is compared with these. The corrections are tabulated over a range suitable for plotting a useful curve. To eliminate the gas correction, conductivity is frequently measured at the atmospheric boiling point. Erroneous impressions of purity obtained by this method result from neglect of the relatively high conductivity of pure water at 100 C, and use of too small a temperature coefficient in correcting the measurement to 25 C. Conductivity measured at 100 C is not necessarily free of gas correction; samples should be checked for gases and the appropriate correction made. The correction for ammonia at 100 C is given.

Construction and Operation of Larson-Lane Steam Purity and Condensate Analyzers. A. B. Sisson, Commonwealth Edison Co., F. G. Straub, University of Illinois, and R. W. Lane, Illinois State Water Survey.

This discussion will consider the development of these instruments and problems encountered, including the effect of various hydrogen exchange resins on effluent conductivity. Corrosion and contamination problems will be stressed. Instrument operation variables will be considered. Emphasis will be placed on operating experiences with these instruments in central stations and in institutional power plants.

Report D-19 on Industrial Water. Max Hecht, Chairman.

Presentation of Max Hecht Award.

Thursday, June 21 8:00 p.m. Twenty-Seventh Session

Held simultaneously with the Twenty-Sixth and Twenth-Eighth Sessions

General Testing Session

Correlation of Tensile Properties in Aluminum Alloy Castings and Separately Cast Test Bars. W. H. Johnson, and H. F. Bishop, Naval Research Laboratory.

This study was undertaken to determine the relationship of casting properties to test bar properties in aluminum alloys. Tension test bars were removed from various locations in 195-T6 and 3..6-T6 alloy castings of different thicknesses and geometries, and the properties obtained compared to those obtained from separately cast web bars. The test castings were plates with lateral dimensions of 4 by 9 in., 4 by 17 in., and 17 by 12 in. and also plate sections joined together to form L, T, and X shapes. The six test castings were cast in thicknesses of ¼, ½, 1, and 2 in. and in each case fed with one edge riser.

The 195 alloy was found to be relatively sensitive to cooling rates. Strength properties were invariably higher at the faster cooling edge regions of the casting than at center regions, regions near the riser contact, and at the hot spots formed at the junctions of L, T, and X shapes. Tensile properties also decreased with increasing section thickness. The average of all tensile properties obtained from all castings of a given thickness showed that tensile strength varied from 120 per cent of test bar strength for the ¼-in. sections to 90 per cent for 2-in. sections.

The 356 alloy was found to be relatively insensitive to cooling rate and section size effects and, as a result, properties throughout any given casting made of this alloy were quite homogeneous. Average tensile strength in the six test castings of a specific thickness varied from 100 to 90 per cent of separately cast test bar strength as section thickness increased from ¼ to 2 in. Elongation values were approximately 40 per cent of test bar values irrespective of section thickness; this relationship was not appreciably affected by grain refiners.

The Effect of Static Mean Stress on the Damping Properties of Materials. Neal L. Person, and Benjamin J. Lazan, University of Minnesota.

An adaptation of a rotating cantilever beam machine for bending vibration decay tests is described as well as its use in studying the effect of static mean stress on the damping of materials. An estimate of the error due to extraneous energy losses is given and equation and procedure for reducing experimental results to specific damping data.

The materials tested in this work were SAE 1020 steel, 2024-T4 aluminum, J-1 magnesium, RC-55 titanium, S-816 alloy, glass laminate, and type 403 alloy. This selection was made to provide a variety of material type and, hence, of damping properties. In all cases the tests were conducted at room temperature and below the cyclic stress sensitivity limit, below which damping is unchanged by stress history. The test results are presented as specific damping energy *versus* alternating stress curves for various mean stresses.

The data presented led to the following conclusions for the materials investigated in the range of maximum stress (mean plus alternating) up to the cyclic stress sensitivity limit:

1. The effect of a static mean bending stress on the damping associated with a given alternating stress is small for materials with little magneto-mechanical effect. A maximum decrease in damping of only 30 per cent was observed for nonferromagnetic materials.

2. Increased static mean stress greatly reduces the damping of materials that have considerable magneto-mechanical damping. The specific damping energy of type 403 alloy decreased as much as 90 per cent with ncreasing static mean stress.

An Ultrasonic Scanning and Recording System. W. J. MacGonnagle and W. N. Beck, Argonne National Laboratory.

A scanning and recording system for ultrasonic testing has been developed using the through transmission technique. The two transducers and the specimen to be inspected are immersed in a water couplant. The two transducers can move laterally and vertically, the two motions being independent of each other. This equipment can be used to inspect either flat or cylindrical samples. Cylindrical samples can be rotated in the couplant.

An electrosensitive paper recorder is used in conjunction with the ultrasonic equipment to make a permanent two-dimensional record of the ultrasonic transmission through the specimen. The electrosensitive paper is darkened by a flow of current, the degree of darkening depending on the current flow through the paper. The current through the paper is determined by the ultrasonic transmission through the specimen.

Evaluation of Test Variables in the Determination of Shear Strength. R. W. Fenn and R. B. Clapper, Dow Chemical Co.

Study of extensive new single-shear, double shear, and punch-shear test results reveal a significant size effect which must be considered in any attempt to compare shear strengths of alloys. Increased apparent shear strength is observed with: (1) decreased specimen shear area, (2) increased pin-to-hole tolerance (double shear), (3) notching of round specimens, and (4) simulated wear of shear jig. Changes in shear strength as a function of specimen and shear jig geometry are also presented. Recommendations are offered for test methods to provide the best approximation to the true shear strength of the material.

Crack Initiation and Propagation in the V-Notch Charpy Impact Specimen. Carl E. Hartbower, Watertown Arsenal.

A technique developed at the Naval Research Laboratory for studying transition behavior has been modified and extended to provide a clearer insight into the mechanics of flow and fracture in the V-notch Charpy impact specimen. The technique consists of prestraining (or precracking) the test specimen with a low-energy blow at a selected test temperature. The amount of strain developed by the low-blow at that temperature is determined (qualitatively) by measurement of the maximum lateral expansion occurring at the compression surface of the specimen opposite the V-notch.

The performance criteria used in connection with the above technique were: (*a*) the magnitude of the low-blow (or strain) required to initiate a fibrous crack and (*b*) the temperature at which the crack-initiating low blow caused brittle fracture of the test specimen: that is, the highest temperature at which crack propagation occurred by action of elastic-stress energy alone. The latter is referred to as the brittle-fracture transition temperature.

By means of the low-blow technique, it is possible to arrive at a simple, informative and less abitrary definition of transition temperature and to derive considerable information on the mechanics of flow and fracture in the V-notch Charpy impact specimen.

A Method for Evaluating Surface Flammability of Materials Using a Radiant Energy Source. A. F. Robertson, D. Gross and J. Loftus, National Bureau of Standards.

Thursday, June 21 8:00 p.m. Twenty-Eighth Session

Held simultaneously with the Twenth-Sixth and Twenty-Seventh Sessions

Soil Session

Research on the Ultimate Bearing Value of Pressure Injected Footings in Lieu of Poured-in-Place Shallow Footings in Granular Materials. Leon A. Fraikin, Franki Foundation Co.

The ultimate bearing capacity of footings resting on dry cohesionless sand is determined at present by semiempirical equations based on experiments.

Water-table conditions, extreme colds, and variations in densities of underground layers, force the engineer to be extremely cautious in using these equations, when footings have to be concreted by ordinary procedures.

The paper points out that it is possible to force definite quantities of concrete into granular soils at a predetermined depth in such a manner as to assure the ultimate bearing capacity of these pressure-injected footings.

Evaluation of Lime Stabilized Loess. J. G. Laguros and D. T. Davidson, Iowa State College, T. Y. Chu, New York University.

This paper presents results of a laboratory investigation of some factors affecting the stabilization of silty and clayey textured Iowa loess with lime. Among the variables studied were chemical composition of lime, length of curing, and temperature and relative humidity during curing. The results indicate that (1) quicklime is more effective than hydrated lime, (2) dolomitic lime imparts higher strength to loess than high calcium lime; but larger amounts of dolomitic lime are required for optimum strength conditions, (3) the strength of stabilized loess is greatly benefited by elevated temperature curing; duration of curing and relative humidity during curing also have an important effect on strength gain, and (4) on the basis of CBR criteria, lime stabilized loess is satisfactory for base course use.

Field and Laboratory Determinations of the Bearing Capacity of Hard Pan for Design of Deep Foundations. W. S. Housel, University of Michigan.

In 1935 the author presented a penetration method for measuring soil resistance based on field-penetration observations made during the process of obtaining undisturbed soil samples, followed in 1936 by the results of several years of laboratory research on the internal stability of granular materials utilizing the stabilometer or triaxial compression test in comparison with direct-shear tests.

For some 20 years the test procedures thus developed have been in constant use as a means of evaluating soil resistance in substructure design including caissons and bearing piles involved in deep foundations. As a result of that experience it is possible at this time to summarize the results of laboratory and field investigations giving a quantitative comparison of both types of tests.

Applications of Environment Testing of Soils. Donald M. Burmister, Columbia University.

This paper is intended to illustrate the practical applications of environment testing of soils, in order to obtain more reliable information and data for use in practical problems in soil and foundation engineering. The problems discussed show what environmental conditions and conditions imposed by the construction of structures can and should be taken into account in the testing of soils, and how they may be introduced into soil-testing procedures in order to achieve the above objectives. Standards of soil testing are used as the basic framework for testing, but in each case special provisions and modifications are introduced in order to fit the testing procedures and techniques to the special environmental conditions that control responses of soils. The principal objective in the soil testing is to reproduce the environmental and imposed conditions in accordance with "simulated service testing" principles, which are becoming so effectively used in testing manufactured products in industry. This is learning "how to test and to treat real soils under essentially real conditions," as an important forward step in soil-testing procedures and techniques.

Simple Charts Illustrating Relationships Between Moisture Content, Density, and Voids Properties of Soils. N. W. McLeod, Department of Transport, Ottawa.

Relationships among five variables for any given soil can be illustrated graphically by means of families of curves on a single rectangular chart. While any two variables can be selected as ordinate and abscissa for this chart, it is generally most useful to employ density as the ordinate and moisture content as abscissa, since these two quantities are measured directly. When values for the moisture content and density of a soil sample have been determined, they can be plotted as a single point on this chart. As soon as this point has been located, the corresponding values for voids ratio, per cent saturation, and per cent air voids for the soil sample can be read directly from the chart.

Friday, June 22 9:30 a.m. Twenty-Ninth Session

Held simultaneously with the Thirtieth Session

A Presentation of Papers and Informal Talks on Various Complex Rheological Problems

Sponsored jointly by Society of Rheology and ASTM Committee E-1

Dynamic Viscosity and Shear Modulus of Molten Polystyrene as a Function of Molecular Weight. W. P. Cox, L. E. Nielsen, and R. Keeney, Monsanto Chemical Co.

The dynamic mechanical properties of molten polystyrene have been investigated in a new concentric cylinder elastoviscometer. Polystyrene fractions of weight average molecular weight ranging from 240,000 to 1,130,000 were studied in the temperature range of 150 to 220 C and the frequency range of 0.02 to 5 cps. Data obtained at different temperatures with a given fraction could be reduced to a single composite curve of dynamic viscosity (or rigidity) *versus* frequency using the reduced variables of Ferry.

Stress-Strain Relations in Soils. Plastic and Frictional. D. C. Drucker, Brown University.

The term soil mechanics would seem to imply a mathematical formulation of the problem and of the basic equations to be used in the solution of such problems. The most essential equations would be the relations between stress and strain or between strain increments and stress increments. It is the purpose of the paper to explore the stress-strain relations for soil in greater detail.

Rheology of Asphalts. W. Philippoff, Franklin Institute.

The asphalts are viscoelastic bodies or non-Newtonian liquids, the properties of which vary extremely with a change in temperature. Dynamic tests could be correlated in a large range by using the method of reduced variables. The instruments used in the investigations are described as well as the results on eleven asphalts chosen to give a general survey of the commercial grades.

The Impact-Absorbing Capacity of Textile Yarns. J. C. Smith, F. L. McCrackin, and H. F. Schiefer, National Bureau of Standards.

The limiting breaking energy density, or energy per gram of yarn required for an immediate impact break, is suggested as a suitable parameter for characterizing this impact-absorbing property. Several methods for measuring limiting breaking energy density are described. Typical data, including stress-strain curves obtained at high rates of straining (5000 per cent per sec) are given for several high-tenacity textile yarns.

The Characterization of Pressure-Sensitive Adhesives. F. H. Wetzel, Hercules Powder Co.

Quantitative methods for a study of factors effecting pressure-sensitive adhesion have been developed. (1) *Tack* is determined as a surface property that defines the instantaneous adhesiveness of the tackifying resin—elastomer mass. (2) *Yield stress* of free films reflects internal strength or cohesion. (3) A study of *viscosity* affords a scale for comparison of long-term flow. These methods are useful in studying pressure-sensitive adhesion as a function of concentration of tackifying resin in pure rubber as well as the effects of accelerated aging.

A New Coal Plastometer. D. C. Hills, Citizens Gas & Coke Utility.

Photographic Method for Sharpening Isochromatic Photoelastic Patterns. R. R. Myers, Lehigh University.

Stresses and Strains in The Shaping of Metal Tubes. E. T. Onat, and W. Prager, Brown University.

Friday, June 22 9:30 a.m. Thirtieth Session

Held simultaneously with the Twenty-Ninth Session

Symposium on In-Place Shear Testing of Foundation Soil by the Vane Method

An Apparatus and Method of Vane Shear Testing of Soils. J. O. Osterberg, Northwestern University.

In-Place Shear Testing of Soils by the Vane Method. Harold J. Gibbs, Bureau of Reclamation.

A vane tester for determining the in-place shearing resistance of saturated clayey soils has been devised with the principal features of a controlled rate of testing and a simplified, accurate method of stress measurement. The instrument applies a balanced-moment torsional force to the vanes and permits measurements of stresses which are not affected by friction in the loading mechanism.

Deep Vane Tests in Gulf of Mexico. Carl W. Fenske, McClelland Engineers.

A vane boring was made at an offshore location in the Gulf of Mexico to a depth of 241 ft below the water surface. A description is given of the tool used to make this boring; this tool combines the functions of drilling and vane testing. An undisturbed sample boring was made adjacent to the vane boring. The results of miniature vane, unconfined compression, and triaxial compression tests are given.

Vane In-Place Soil Shear Measuring Device. W. A. Hill, Oregon State Highway Dept.

A vane type, "in-place," soil shear testing device has been built by the Construction Division of the Oregon State Highway Department, and used since 1953 in investigating questionable embankment foundation areas along proposed projects. The development of the device and the technique of using it are discussed. A review is made of the correlation between "in-place" soil shear strengths and laboratory direct shear tests made on "undisturbed" soil samples.

Friday, June 22 12:00 noon Thirty-First Session

Held simultaneously with the Thirty-Second Session

Committee Report Session

C-7 on Lime, J. A. Murray, Chairman.

C-11 on Gypsum. G. W. Josephson, Chairman.

D-2 on Petroleum Products and Lubricants. Harold M. Smith, Acting Chairman.

D-3 on Gaseous Fuels. L. T. Bissey, Chairman.

D-8 on Bituminous Waterproofing and Roofing Materials. H. R. Snoke, Chairman.

D-11 on Rubber and Rubber-Like Materials. Simon Collier, Chairman.

D-15 on Engine Antifreezes. H. R. Wolf, Chairman.

D-18 on Soils for Engineering Purposes. E. J. Kilcawley, Chairman.

Friday, June 22 12:00 noon Thirty-Second Session

Held simultaneously with the Thirty-First Session

Committee Report Session

A-3 on Cast Iron. H. W. Stuart, Chairman.

D-6 on Paper and Paper Products. W. R. Willets, Chairman.

D-9 on Electrical Insulating Materials. A. H. Scott, Chairman.

D-10 on Shipping Containers. G. E. Falkenau, Chairman.

E-2 on Emission Spectroscopy. J. R. Churchill, Chairman.

E-7 on Nondestructive Testing. J. H. Bly, Chairman.

E-13 on Absorption Spectroscopy. E. J. Rosenbaum, Chairman.

E-14 on Mass Spectrometry. M. J. O'Neal, Chairman.

F-1 on Materials for Electron Tubes and Semiconductor Devices. S. A. Standing, Chairman.

ASTM Bulletin

APRIL 1956

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NINETEEN-SIXTEEN
RACE STREET
PHILADELPHIA 3, PENNA.

Society Officers Find Enthusiasm for West Coast Meeting—Urge Attendance at Annual Meeting in June

WE ADMIT we are prejudiced in drafting this message to our members and committee members. While it is written in the shadow of Utah's Eternal Hills we are now and will be for many months to come influenced and inspired by the enthusiasm of our hard-working California members who are handling arrangements for the Society's Second Pacific Area National Meeting in Los Angeles, September 16–22.

What a meeting this will be. Every member and committee member who possibly can should arrange to get to it.

But before describing the outstanding features of this West Coast Meeting, a word about the Annual Meeting and Exhibits to be held in Atlantic City, the week beginning June 17. No other meeting can or should detract from the interest in and the importance of this highlight of the ASTM year. It is expected, for example, that again there will be over 600 meetings of our technical committees. No organization can boast of such concentrated effort on the part of our country's leading technical authorities.

We have been impressed by the growing number of members west of the Mississippi who are becoming active in committee work. We welcome more of this, for these committees are the life blood of the Society. Only very rarely do we find a technical man who has served on a committee not finding it beneficial for both himself and his organization.

Such a concentration of committee meetings will bring large numbers to Atlantic City, but coupling these with an interesting technical program of significant papers and reports, plus two exhibits provides an Annual Meeting that is outstanding.

Details of the technical program appear in this BULLETIN. This material will give you an idea of the caliber of men who help maintain ASTM as an authoritative source for sound knowledge of the properties of materials and an idea of the diversity of our coverage. Much helpful information is to be gained at such a meeting, and a man's value to his company is greatly enhanced.

In evaluating materials, a wide range of apparatus and instruments must be available. The Twelfth Apparatus Exhibit alone will be worth your attendance. And you will find of interest the technical photographic display. The men interested in metals will again find the Metallography section of the Exhibit worth careful study.

Considering the above, we are justified in urging you if at all possible to come to Atlantic City in June.

But consider also the facts noted below which we, together with our West Coast members and other National Officers, believe support our contention that you should

come to Los Angeles in September

Technical Program.—The program will be the most extensive ever sponsored at any meetings of ASTM thus far. Over 40 separate technical sessions, upwards of 225 papers. Three sessions will provide summary papers on the Effect on Materials of Exposure to Radiation; two or three sessions *each* will be devoted to nondestructive testing, the use of radioactive isotopes, petroleum products and lubricants, soils, industrial waters, railroad materials, cement and concrete and others. The quality of these sessions is assured with many of our technical committees sponsoring them.

Committee Meetings.—Several of our larger committees will hold meetings, and while there will not be as many as in Atlantic City much important work on standards and research will take place.

National and Industry Luncheons.—Special features are to be provided by a President's National Luncheon and seven Industry Luncheons at each of which prominent speakers will cover subjects germane to the group interests involved. Luncheons are scheduled in the areas of Petroleum Products, Wood, Paints, Soils, Railroad Materials, Water, and Cement and Concrete. Business leaders will be invited to these luncheons.

Exhibits.—A special West Coast Apparatus and Instrument Exhibit will be in progress at the Statler and at least the prize-winning photographs from the Annual Meeting, will be on display.

Plant Visits.—A special committee will list a number of laboratories and industrial plants where you will be welcome.

Entertainment.—Southern California is noted for its hospitality and entertainment. On each day of the meeting, the ladies will have something of keen interest including specially conducted tours to Disneyland, Marineland, Metro-Goldwyn Studios, and others. The General Committee on Arrangements plans to subsidize a considerable portion of this entertainment. They are anxious that the wives and families of many of our members will attend. The completely air-conditioned Hotel Statler provides an ideal location for this meeting.

About May 15 you will receive a special program and brochure on this meeting. Discount as you wish our enthusiasm and that of our West Coast members for this meeting; you and your organization will find it beneficial to be there. Be on the lookout for this special brochure. Full details will be given.

Our Appreciation.—We are pleased to have had the opportunity of meeting many of our West Coast members. In Los Angeles we had virtually three full days of meetings with the officers and members of the General Committee on Arrangements for our West Coast Meeting and, as indicated, a more interested and harder working group you will not find. Several meetings also were held in San Francisco because the Northern California

District there is cooperating closely with the Southern California group. We find some divergence of opinion on the respective merits of San Francisco and Los Angeles, but we find unanimous agreement on the desire to support ASTM and to make this West Coast meeting outstanding.

Everywhere we go we find intense interest in materials—a continuing challenge to ASTM. Since 1902, the Society has made notable contributions in its work on research and standardization in the field of materials but much more remains to be done. This bids well for an active and virile Society.

CLAIRE H. FELLOWS

President

ROBERT J. PAINTER

Executive-Secretary

Society Officers Nominated

THE NOMINATING COMMITTEE met at ASTM Headquarters in Philadelphia on February 24 to select nominees for the Society offices of President, Vice-President, and five Directors.

In accordance with the Bylaws of the Society, the Nominating Committee has announced the following nominations:

For President (term 1 year):

R. A. Schatzel, vice-president and director of engineering, Rome Cable Corp., Rome, N. Y.

For Vice-President (term 2 years):

K. B. Woods, head, School of Civil Engineering and director, Joint Highway Research Project, Purdue University, Lafayette, Ind.

For Directors (term 3 years):

M. N. Clair, president, The Thompson and Lichtner Co., Inc., Brookline, Mass.

H. C. Cross, metallurgist, Battelle Memorial Inst., Columbus, Ohio

G. H. Harnden, consultant, materials and processes, Engineering Standards Service, Engineering Services Div., General Electric Co., Schenectady, N. Y.

R. R. Litehiser, engineer of tests, Ohio State Highway Testing Laboratory, Columbus, Ohio

C. R. Stock, group leader, Physical Measurements Group, American Cyanamid Co., Stamford, Conn.

The Bylaws provide that "further nominations, signed by at least 25 members, may be submitted to the Executive Secretary in writing by May 25, and a nomination so made, if accepted by the member nominated, shall be placed on the official ballot" which "shall be issued to members between May 25 and June 1."

Committee on General Arrangements for 1956 Second Pacific Area Meeting

Photographed at their meeting with President Fellows and Executive Secretary Painter are the men in charge of the big job of planning the West Coast meeting. Front Row, left to right: Harry Welch, Vice-Chairman, Plant Visits Committee; W. C. Hanna, Honorary Chairman, and W. M. Barr, Honorary Vice-Chairman. Second Row, seated, left to right: M. B. Niesley, Secretary; C. H. Fellows, President ASTM; C. M. Wakeman, Chairman; B. P. Weintz, Treasurer, and R. J. Painter, Executive Secretary ASTM. Standing, left to right: C. E. Emmons; C. E. P. Jeffreys, Vice Chairman Social Committee; C. W. Beardsley, Chairman, Transportation Committee; R. B. Stringfield, Chairman, Hotels Committee; Guy Corfield, Vice-Chairman, Transportation Committee; E. F. Green, Chairman, Information Committee; Ed Valby; Arnold Tuckerman; E. R. Millett, Jr., Chairman, Social Committee; Gerald Christiansen; J. B. Howe, Chairman, Promotion and Publicity Committee; P. J. Rich, Chairman, Technical Program Committee; F. B. Doolittle, Chairman, Plant Visits Committee; Jim Long; G. R. Little; C. R. Baker, Vice-Chairman, Industry Luncheons Committee; and D. E. Bowers, Vice-Chairman, Hotels Committee.

District Activities

PHILADELPHIA

MEMBERS of the ASTM Philadelphia District and friends from other societies, notably AIEE, AIME, and ASME, turned out in force to make the second annual President's and Students' Night at the University of Pennsylvania as successful as the first such program which was held last year at the Drexel Institute of Technology.

President Fellows' address, "Research in the Electric Power Industry," was well received by the 135 in attendance.

At the dinner preceding the technical session the Philadelphia council members were hosts to 21 student-membership award winners. The recipients of these awards presented by President Fellows and District Chairman E. K. Spring, are shown in the accompanying photograph. Nine other students not shown in the photograph were unable to attend either because of travel difficulties or prior commitments.

The arrangements for the evening were under the direction of Carl C. Chambers, vice president in charge of engineering affairs, University of Pennsylvania and Dale T. Harroun, associate professor of civil engineering.

At the Philadelphia District Meeting, left to right, are: C. C. Chambers, vice president in charge of engineering affairs, University of Pennsylvania; D. T. Harroun, associate professor of civil engineering, University of Pennsylvania; ASTM President C. H. Fellows, The Detroit Edison Co.; Executive Secretary R. J. Painter; and ASTM Philadelphia District Chairman E. K. Spring, Henry Disston and Sons Div., H. K. Porter Co.

Philadelphia Area Engineering Students—Recipients of ASTM Student Membership Awards. Standing, left to right: William A. Snyder, *Lehigh;* Daniel E. Price, Leonard Stander, Robert I. Brewer, *Drexel;* H. Clark Carbaugh, William Craig, *University of Delaware;* Edward Kottcamp, *Lehigh;* Jordan Dannin, *Philadelphia Textile Institute;* Joseph Mullin, David Margolis, *Drexel.*
Seated, left to right: Reinier Hijman, *Swarthmore;* Walter M. Bird, Edward H. Adam, *Drexel;* John Salvador, Jr., Ronald C. Brucker, *Lafayette;* Edward S. Perry, F. Homer Eaton, *Princeton;* Marvin S. Podolnick, James Onorato, *University of Pennsylvania;* Vincent Mulé, Francis McFarland, *Villanova.* The following Award Students were unable to attend: Van C. Martin, Richard B. Ulp, *Bucknell;* John D. Antrim, Uel D. Jennings, *Lehigh;* Stanley Lewis, *Philadelphia Textile Institute;* John F. Conly, Stephen B. Gray, Karl F. Lukens, Jr., Paul J. McGonigal, *University of Pennsylvania.*

The Head Table—Southern California District Meeting, left to right: Carroll M. Wakeman, City of Los Angeles Harbor Dept.; ASTM Past-President William H. Barr; President Claire H. Fellows; District Chairman M. B. Niesley, California Testing Labs., Inc.; G. Hallen, Chairman, ASME Southern California Section; Executive Secretary R. J. Painter; W. C. Hanna, California Portland Cement Co.; F. J. Fontana, Vice-Chairman, ASME Section; and Shuman M. Moore, Secretary-Treasurer, ASME Section.

Officers Visit Southwest and Southern and Northern California Districts

ASTM PRESIDENT Claire H. Fellows and Executive Secretary R. J. Painter logged 10,000 miles or more on a six-week trip which took them through New Orleans and Houston to Los Angeles; up the Pacific Coast to Vancouver on a dog-leg route through San Francisco and Salt Lake City; and back to Toronto via the Canadian Pacific through Canada. They left February 28 immediately after the Buffalo District meeting, held in connection with Committee Week, and spoke at 11 meetings enroute which had been arranged by local groups or districts, in cooperation with other societies.

The Louisiana Engineering Society arranged a luncheon meeting in New Orleans on March 1 in cooperation with local ASTM members. Although New Orleans is included in the Southwest District, most of the Southwest District meetings have been held in Texas, with one exception last year in Bartlesville, Okla. Both the President and Executive Secretary feel additional meetings in the area are desirable. Arrangements for the meeting were expedited by R. M. Seago, past president, and J. P. Fernandez, secretary-treasurer, of the Louisiana Engineering Society, and F. J. Baehr, Jr.

The meeting in Houston on March 5 was held jointly with the Power, Technical and Industrial Application Groups of the Houston Section of the American Institute of Electrical Engineers. More than 50 were at the meeting which was preceded by a Council dinner at Rice Institute. Milton Holmberg, chairman of the Southwest District, coordinated the meeting for ASTM with H. J. Kongabel, chairman of the Houston Section of AIEE.

At Los Angeles the President gave his talk for the third time in a week at a meeting cosponsored by the ASTM and The American Society of Mechanical Engineers. George Hallen, local chairman of the ASME Southern California Section, introduced Myron Niesley, chairman of ASTM's Southern California District, who in turn introduced those at the head table. Mr. Painter commented briefly on joint ASTM-ASME activities and some new ASTM activities. Carroll Wakeman, Los Angeles Harbor Dept., then introduced Mr. Fellows as the speaker of the evening.

One of the best meetings was arranged by the Northern California District in San Francisco on March 13. This was again a joint meeting with the AIEE and more than 100 members and guests of the two societies were present. A number of former and current ASTM officers were present including P. V. Garin, a current Director; H. C. Mougey (retired), former member of the Executive Committee; A. O. Schaefer, former ASTM Director and current President of ASM; and Dozier Finley, 1949 West Coast Meeting Chairman. Whitman Ridgway, General Electric Co., chairman of the local AIEE section, opened the meeting and then introduced ASTM District Chairman Harry Hoopes, who presided for the rest of the evening.

WASHINGTON

NOT TO BE outdone by the efforts of their Richmond friends several years ago, the Baltimore group of the Washington, D. C., District sponsored a very pleasant and well-attended social hour and reception for President Fellows at the Sheraton Belvedere Hotel in Baltimore on January 27, 1956. More than 175 members of ASTM and the Baltimore Engineers Club were in attendance. It was particularly gratifying that there were approximately 50 ladies present. The social hour and reception for the President preceded the dinner and program which were under the direction of E. F. Wolf of the Baltimore Gas and Electric Co.

President Fellows spoke briefly on the work of the Society and particularly his interest in having seen the formation of the first district council—Chicago—and the fact that the councils now total 14 in number.

Joseph L. Gillman, Jr. of Joseph Gillman Associates, the guest speaker of the evening, emphasized in his "Technological Prognostications" his belief that man is faced with possible self-extinction. He feels it is up to every individual to concern himself with whether our future generations will be reduced to caveman status or will be raised to a "milk and honey" level. Technological achievements to date include a speed of more than 1500 mph in the air and the ability of the *Nautilus* to travel more than 1500 miles under water at an average speed of 16 knots. On the debit side are the constant preparation for offense and defense, including the development of Nike, the Matador, and the Corporal. Currently under development is the 100-ft-long Atlas, weighing on the order of 240,000 to 500,000 lb, which will travel at the rate of three to four miles per second at an altitude of 700 to 800 miles, and will have a speed of 9000 miles an hour when it strikes its target. Mr. Gillman pointed out that ways and means must be found to produce more and better engineers and scientists and that our future lies in the mastery and peaceful applications of nuclear processes, space flight, and automation.

Assisting R. W. Seniff, Vice President of the Washington District Council, in his preparations for this meeting were: J. E. Wood, Maryland State Roads Commission; M. C. Hewett, American Oil Co.; L. W. Shuger, Baltimore

Paint & Color Works; J. B. Armstrong, Bethlehem Steel Co.; R. C. Fitzgerald, Baltimore Gas & Electric Co.; Herman Hollerith, Glenn L. Martin Co.; W. T. Long, Maryland State Roads Commission; George Kimber, Calcium Chloride Institute; and J. R. Dwyer, National Bureau of Standards.

ST. LOUIS

AT A JOINT dinner meeting of the ASTM St. Louis District and the St. Louis Chapter of the Missouri Society of Professional Engineers, President C. H. Fellows presented his address "Research in the Electric Power Industry" to more than 100 members of both groups.

MSPE President Walter Rathell opened the meeting and J. M. Wendling, chairman of the ASTM District, introduced Executive Secretary Painter and President Fellows. The Executive Secretary pointed out that in 1958, during the week of February 9, ASTM will hold its first national meeting in St. Louis—Spring Meeting and Committee Week.

In his address, President Fellows noted the valuable work which ASTM has done for the utility industry and conversely the intensive work of utility technical leaders in ASTM committee and administrative work. He showed a series of excellent slides of the laboratories and investigative work at his company, Detroit Edison, and followed with a number of interesting case histories of problems and developments.

The St. Louis Chapter of the Missouri Society of Professional Engineers, a very active group, is growing considerably and has interesting regular meetings. Other ASTM district officers at the meeting included W. C. Magruder, District Vice-Chairman, and J. R. Romig, District Secretary.

Errors in Binding

IN AN effort to speed the appearance of the compilation on ASTM Standards on Copper and Copper Alloys, two errors were made in binding.

The printer failed to include an insert plate showing the grain size chart in connection with Methods E 79, which is a serious omission. Copies of the chart are being mailed to all purchasers of record. All members of the Society concerned should request a copy from headquarters.

In some few of the copies a wrong signature appears which means that pages 515 to 534 are in error. All those who have an incorrect copy should return it to headquarters and a copy bearing correct pages will be forwarded in its stead. At the same time the missing insert plate will be inserted in these copies.

NEW ASTM PUBLICATIONS

ASTM Standards on Light Metals and Alloys,

THIS third edition, sponsored by Committee B-7 on Light Metals and Alloys, includes not only those specifications and methods of test which come under the jurisdiction of Committee B-7 but also those for light-metal-alloy die castings, prepared by Committee B-6 on Die Castings, and those for aluminum wire and cable for electrical purposes, sponsored by Committee B-1 on Wires for Electrical Conductors. Several methods under the jurisdiction of Committee E-1 on Methods of Testing and Committee E-3 on Chemical Analysis of Metals have been added to make the compilation as useful as possible. In addition, a specification for aluminum and aluminum-alloy arc-welding electrodes and for brazing filler metal under the jurisdiction of the AWS-ASTM Joint Committee on Filler Metal have been included.

Appendices include a Codification System for Light Alloys, and the Personnel of Committee B-7.

This compilation, 276 pages in heavy paper covers, can be obtained from ASTM Headquarters, 1916 Race St., Philadelphia, Pa. Price: $3.50; to members, $2.65.

ASTM Standards on Mineral Aggregates and Concrete

THE VARIOUS ASTM standard and tentative specifications, test methods, and definitions of terms pertaining to mineral aggregates, concrete, and selected highway materials, are brought together or referenced in this publication.

This revised compilation sponsored by Committee C-9 on Concrete and Concrete Aggregates and Committee D-4 on Road and Paving Materials includes all of the standards prepared by Committee C-9 but only those for aggregates and other selected highway materials developed by Committee D-4. In addition, it contains pertinent specifications for cement which are under the jurisdiction of Committee C-1 on Cement. A companion book to this publication is available covering all materials of a bituminous nature used in highway construction and in the waterproofing and roofing fields.

This 360-page volume, can be obtained from ASTM Headquarters, 1916 Race St., Philadelphia, Pa. Price: $3.75, to members, $2.80.

Standards on Textiles

THE NEARLY 200 ASTM test methods, definitions, and specifications developed by one of the Society's largest committees, D-13 on Textile Materials, are presented in this compilation. Included are eleven new tentative methods of test relating to warp knit fabrics, pilling propensity of textile fabrics, test for wide elastic fabrics, abrasion resistance of textile yarns, absorbency time and absorptive capacity of nonwoven fabrics, analysis of asbestos-glass fiber textile materials, maturity of cotton fibers, spun and filament yarns made wholly or in part of man-made organic base fibers, and stiffness of fabrics.

Adding to the value of this publication are appendices on Basic Properties of Textile Fibers, Psychrometric Table for Relative Humidity, Yarn Number Conversion Table, and seven proposed methods under study.

This indexed volume in heavy paper cover, 786 pages, can be obtained from ASTM Headquarters, 1916 Race St., Philadelphia. Price: $5.75, to members, $4.40.

ASTM Standards on Copper and Copper Alloys

125 QUALITY standards relating to copper and copper alloys are included in this compilation. These standards cover plate, sheet strip, rolled bar, wire rods, bars, shapes, die forgings, pipe, tube, castings, filler material and copper-covered steel electrical conductors.

Most of these standards were developed by ASTM Committee B-5, working in the field since 1909. Several are under the jurisdiction of ASTM Committees B-1 on Wires for Electrical Conductors and B-2 on Non-Ferrous Metals and Alloys and are included for convenience because they relate to the copper group.

Copies of this 654-page compilation can be obtained from ASTM Headquarters, 1916 Race St., Philadelphia. Price: $5.75; to members, $4.40.

Actions on Standards

MAGNESIUM OXYCHLORIDE CEMENTS

Tentative Specification for Oxychloride Magnesia (C 275 – 51 T) (Approved Jan. 27, 1956)

Revised as a result of continuing research on the physical properties of oxychloride magnesia which indicated modification of the specification in two places: in Section 3, Chemical Requirements, the requirement for active calcium oxide is increased from 1.5 to 2.0; in Section 6, Physical Requirements (Table I) reference to gross (or net) contraction. . . 0.60 is deleted.

GYPSUM

Tentative Specification for Precast Reinforced Gypsum Slabs (C 377 - 56 T) (Approved Jan. 27, 1956)

This new specification for material not previously covered was requested by building code and design people. These slabs consist essentially of gypsum, metal reinforcing, and wood fiber, chips, or shavings. They are of two types: short span slabs designed for end support on subpurlins and long span slabs designed for support on primary structural framing.

Methods of Testing Gypsum and Gypsum Products (C 26 - 54) (Approved Jan. 27, 1956)

Revised to include methods of testing flexural strength and nail retention of the precast reinforced gypsum slabs specified in the new tentative C 377 (see above).

GLASS AND GLASS PRODUCTS

Tentative Photometric Methods for Chemical Analysis of Glass Sand (C 146 – 56 T) (Approved Jan. 27, 1956)

General developments of photometric analytical procedures have permitted adaptations to glass sand analysis. Particularly for low concentrations the recommended procedures give increased accuracy for less analytical time. Also included is a rapid method for estimation of silica by difference. These methods are not intended to preclude other methods that yield results of acceptable accuracy. When adopted by the Society these methods will be incorporated in the Standard Methods of Chemical Analysis of Glass Sand (C 146 – 43).

THERMAL INSULATING MATERIALS

Tentative Specifications for Mineral Wool Block or Board Insulation (for Low-Temperatures) (C 378 – 56 T) (Approved Jan. 27, 1956)

These new specifications, covering composition, physical properties, and dimensions of mineral wool block or board insulation at temperatures up to 200 F, meet a need in the field of low-temperature surfaces and refrigerated surfaces requiring close control of temperature.

ELECTRICAL INSULATING MATERIALS

Tentative Method for Dielectric Proof-Voltage Testing of Thin Solid Electrical Insulating Materials (D 1389 – 56 T) (Approved Jan. 27, 1956)

This new method of test is intended to apply principally to flat materials but may be applicable, with modification, to any form that permits continuously passing the material between suitable electrodes.

Occasional dielectric defects may be found in commercially available and acceptable thin electrical insulating materials. More often than not, these materials are used in layers. The probability that occasional dielectric weak spots will coincide from layer to layer is very small but increases with the frequency of occurrence of these defects. The dielectric proof-voltage test serves to indicate the frequency of occurrence of dielectric defects and facilitates the isolations of areas where the defects are excessive. This test is nondestructive to acceptable material when proper precautions are taken.

Tentative Methods of Testing Pasted Mica Used in Electrical Insulation (D 352 – 55 T) (Approved April 2, 1956)

Revised to provide a clarification of the test for stability under heat and pressure and clarification of sections on mica or binder content. Sections 14 through 19 are replaced by new sections on Stability under Heat and Pressure setting forth Methods "A" and "B."

Method "A," Perpendicular Method, utilizes the application of a compressive force perpendicular to the faces of the specimen. Method "B," Angular Method, utilizes the application of a shearing force as well as a compressive force which is accomplished by placing the specimen between specified wedges thereby causing the applied force to resolve into compression and shear components. In commutator assembly end use both forces are encountered and this method is recommended in preference to method "A" when material will be used as commutator segment insulation.

Sections 20 through 26, Mica or Binder Content, are replaced by new sections which clarify the method. The mica or binder content relates the proportional weights of mica and binder contained in the material. These proportions affect the physical and electrical properties of bonded micaceous materials.

Tentative Method of Test for High-Voltage, Low-Current Arc Resistance of Solid Electrical Insulating Materials (D 495 - 48 T) (Approved April 2, 1956)

Revised to include in an appendix a procedure for determination of surface breakdown voltage ratio after failure of specimens. Certain insulating materials recover a substantial measure of their insulating value upon cooling after surface failure under electrical arcing. The degree to which a material will recover, after arcing is stopped, from the "failure" that may exist under arcing conditions is of great significance to the designer of electrical equipment.

The method is also revised editorially throughout.

Tentative Methods of Testing Silicone Insulating Varnishes (D 1346 – 54 T) (Approved April 2, 1956)

Revised to add definite instructions for measuring the time of drying of silicone varnish films when such varnishes are tested according to the procedures of the method.

1300 in Buffalo for ASTM Committee Week

350 Meetings of Main Committees and Subgroups

THIRTY-THREE of ASTM's technical committees held approximately 350 committee and subcommittee meetings at the Society's annual Committee Week at the Statler Hotel, Buffalo, N. Y., February 27 to March 2. About 1300 technical men worked intensively during the five days of meetings discussing and correlating the great amount of research upon which ASTM specifications and methods of test are based, and in putting into final shape new and revised tentatives and standards which the several committees will recommend to the Society for adoption at its Annual Meeting at Atlantic City in June. Committee actions in most cases will be submitted to letter ballot of the committees prior to being submitted to the Society for action at the Annual Meeting.

President's Reception

A President's Reception and Dinner in honor of ASTM President Claire H. Fellows was held Tuesday evening sponsored by the Western New York-Ontario District. Special credit for the success of this event goes to District Chairman F. A. Webber, Wickwire Spencer Steel Div., Colorado Fuel and Iron Corp. Mr. Webber, ASTM Executive Secretary R. J. Painter, and Mr. Fellows each spoke briefly. The program for the evening was an interesting talk on "Sports Car Racing—Technical Aspects and Experiences," by William F. Milliken, Jr., Head, Flight Research Dept., Cornell Aeronautical Laboratory, Inc., Buffalo, N. Y.

Symposium on Electrodeposited Metallic Coatings

An important highlight of the week's technical activities was an all-day symposium on Wednesday on "Properties, Tests, and Performance of Electrodeposited Metallic Coatings." The symposium, sponsored by ASTM Committee B-8 on Electrodeposited Metallic Coatings, drew an interested audience of more than 300. (For a complete report of this session, please turn to page 38.)

Cast Iron

The Advisory Group of Committee A-3 acted to expand American participation in the international standardization activity on cast iron. At the last meeting of ISO/TC-25 on Cast Iron, in England, America participated in the work leading toward an international specification for gray-iron castings. International task groups have also been organized on (1) malleable iron, (2) nodular iron, and (3) methods of testing. W. A. Kennedy of Grinnell Co. was appointed American representative to the Malleable Iron Task Group; T. E. Eagan of Cooper-Bessemer Corp., to the Nodular Iron Task Group; and G. A. Timmons to the Testing Methods Task Group.

A new subcommittee on austenitic cast iron has been organized in Committee A-3 and will start a program of work leading toward the development of specifications for this product.

Revisions in several existing cast-iron specifications have been approved by the committee and will be submitted to the Society for approval at the Annual Meeting. In Specification A 48 for Gray Iron Castings, a new class 45 has been added. Several other revisions concern the choice of test bars. The test bars presently prescribed have received various criticisms and the committee took the first step in overcoming these objections by appointing a special task group to conduct an over-all survey of test bar design for determining properties of cast iron.

Corrosion of Iron and Steel

Committee A-5 reported that new work nearing specification stage includes zinc-coated poultry netting and zinc-coated armour wire. This committee is also planning to sponsor a compilation of its standards which will be useful to all those interested in the use of zinc coatings for corrosion protection of iron and steel articles.

Revisions of standards now in the letter ballot stage include consideration of the bend test for adherence in Specification for Zinc-Coated (Galvanized) Iron or Steel Sheets, Coils and Cut Lengths (A 93); and deletion of the sheet weight test in Specification for Long-Terne Iron or Steel Sheets, Coils and Cut Lengths (A 308).

The committee is planning to study the desirability of preparing recommended practices for inspection of galvanized products. Also of interest to the hardware people is the proposed

The President's Reception in Buffalo sponsored by the Western New York-Ontario District. Left to right: District Vice Chairman G. J. Gaukroger; Executive Secretary Painter; Past President J. G. Morrow; W. F. Milliken who spoke on auto racing; District Chairman F. A. Webber; President Fellows; Vice President R. A. Schatzel; T. L. Mayer; Associate Executive Secretary R. E. Hess; and G. H. Von Fuchs.

new atmospheric exposure program of hardware specimens. The current stage of this study is that the coatings are now being applied to the basis materials, and after thickness measurements are made the specimens will be exposed at Kure Beach, N. C., and Newark, N. J.

J. G. Thompson of the National Bureau of Standards who has recently retired from the Bureau and consequently from the committee, having served for many years as its vice-chairman, has been replaced by H. F. Hormann, Consolidated Edison Co. of New York.

Malleable-Iron Castings

Committee A-7 will request the ASTM Advisory Committee on Corrosion for an allotment of space at its exposure test sites, to rate malleable iron on its resistance to atmospheric corrosion. Standard malleable and pearlitic malleable, both copper-free and copper-bearing, will be exposed at such sites as Kure Beach, East Chicago, Galveston, Point Reyes, and the New York City area.

A résumé of tests conducted on malleable irons to determine low temperature, impact, compression, and other mechanical properties was presented; and a discussion was held on the basic property studies and elevated temperature tests being conducted by the Malleable Founders' Society at Purdue University.

A report was also given on the cooperative work with Committee B-8 on Electrodeposited Metallic Coatings on a tentative recommended practice for preparation of malleable and other ferrous castings for electroplating.

Iron-Chromium-Nickel and Related Alloys

After several years of developing a rather complete list of all the super-strength alloys commercially available, together with their mechanical properties, the committee will begin to develop specifications for many of these materials. Prototype specifications will first be developed for one alloy from each of the three groups, then for additional alloys. Alloy 16-25-6 will be representative of the hot cold-worked alloys, A 226 for the precipitation-hardened group, and N 155 for the casting alloys. There is still some question as to the correct definition of "super-strength alloys," so the committee has appointed a task group to develop a definition which will have the approval of the entire group.

Investment castings will be studied to decide whether there is sufficient interest to warrant specifications in this area.

Cognizant of the formation of the Administrative Committee on Nuclear Reactor Materials, Committee A-10 is organizing a task group to study its part in this work.

Wires for Electrical Conductors

After three years of effort by Committee B-1 and special industry advisers the committee accepted for letter ballot statistical sampling procedures in ASTM Tentative Specifications for Tinned Soft or Annealed Copper Wire (B 33) and for Lead-Coated and Lead-Alloy-Coated Soft Copper Wire (both for electrical purposes) (B 189).

Tentative Specifications for Silver-Coated Soft or Annealed Copper Wire (B 298) first published in 1955, are under consideration for revision in 1956. This product has become increasingly important in high-temperature applications. Two new classes will be added, including wires whose silver coating amounts to $2\frac{1}{2}$ and 6.1 per cent of the total weight.

ASTM Specifications for ACSR Conductors (aluminum conductors, steel reinforced) (B 232) will be revised to permit steel core wire with galvanized coatings heavier than standard weight to be used. A second class of conductors for weather-resistant use having a lay not less than 8 nor more than 16 times the outside diameter of the conductor will be added.

Light Metals and Alloys

The continuous development of new alloys and improvement in chemical tolerances and mechanical properties of alloys currently contained in the ASTM specifications gives Committee B-7 a constantly heavy work load.

Committee actions concerning revisions of existing standards (subject to letter ballot approval of the committee) are summarized as follows: B 24 on Aluminum Ingots for Remelting to be withdrawn; B 179 on Aluminum-Base Alloys in Ingot Form for Sand Castings, Die Castings, and Permanent Mold Castings will have an aluminum-magnesium alloy, a piston alloy, and a modified G4A alloy added; B 274 on Aluminum and Aluminum-Alloy Pipe and Tube for Pressure Vessel Applications will have revisions in wall-thickness tolerances.

Specifications B 178 for Aluminum and Aluminum-Alloy Sheet and Plate for Pressure Vessel Applications, B 209 for Aluminum and Aluminum-Alloy Sheet and Plate, B 210 for Aluminum-Alloy Drawn Seamless Tubes, and B 274

At a luncheon meeting of the Advisory Committee of ASTM Committee A-10 held during Committee Week, were, left to right: R. B. Gunia, L. B. Fonda, J. S. Pettibone, Jerome Strauss, M. A. Cordovi, R. H. Heyer, O. B. Ellis, and J. J. Kanter.

for Aluminum and Aluminum-Alloy Pipe and Tube for Pressure Vessel Applications are being considered for revision with respect to the copper limits for MG11A. Method of Test for Sealing of Anodically Coated Aluminum (B 136) will be editorially revised to permit use of a new type of dye. Method of Measuring Thickness of Anodic Coatings on Aluminum by Means of the Filmeter (B 244) will be recommended for adoption as standard.

New tentatives under way include: drawn seamless aluminum tubing, aluminum-alloy fasteners, aluminum standard structural shapes, round aluminum welded tubes, color code for aluminum-alloy ingots, and specifications for producing anodic treatments for aluminum building panels.

Electrodeposited Metallic Coatings

One of the highlights of the B-8 meeting was the Symposium on Properties, Tests, and Performance of Electrodeposited Metallic Coatings (see page 38).

Much of the work reported in the symposium developed from atmospheric corrosion tests exposed under the direction of Subcommittee II on Performance Tests. This subcommittee is currently planning to expose Program No. 4, the fourth series of tests on copper-nickel-chromium coatings on steel designed to evaluate the effect of various controllable factors such as buffing, the use of a copper flash, double layers of nickel, etc.

In the field of standards, a recommended practice for preparation of and plating on lead and lead alloys has been developed and is currently being submitted to letter ballot of the committee.

Metallography

Committee E-4, recognizing that ASTM Method E 3 for Preparing Metallographic Specimens was becoming out of date, has started to gather information on various techniques which are now in use to a much greater extent than when Method E 3 was last reviewed. One of these is a recommended practice for the electrolytic polishing of metallographic specimens. The first draft has been distributed to interested individuals, and was given a critical review.

For several years, development of a nomenclature for identification of phases in metallic systems has been studied intensively both here and by consulting authorities abroad. It appears now that general agreement has been reached on a system and a first draft of the proposal will be written in the near future.

Lime

A tentative specification for the use of fly ash with lime, subject to confirming letter ballot of Committee C-7, will be presented to the Society for acceptance. A round-robin series of tests using the proposed specification, will establish further data. Attention will now be given to pozzolans other than fly ash.

An illustrated report was presented by Prof. W. C. Voss, on research on the expansion of lime, in which four laboratories have collaborated. It is expected that following the completion of this program, clauses will be proposed for the specifications on lime, which will clarify soundness of lime in mortars.

A new program of research on building limes at the National Bureau of Standards, sponsored by the National Lime Assn., will be followed by the committee with interest. A proposed method utilizing versenates for determining calcium and magnesium was accepted for publication as information in the ASTM BULLETIN. Five revisions were accepted in the standard on sampling (C 50). Essentially editorial in nature, they involve the title, and size of sample, among other items. The standard on chemical analysis (C 25) will now include an appendix which will contain information from the U. S. Geological Survey on the Analysis of Silicate and Carbonate Rocks, formerly contained in a reference only.

Refractories

A new analytical method for determining the carbon in carbon refractories was presented to Committee C-8 for publication as a tentative revision of the Methods of Chemical Analysis of Refractory Materials (C 18). The committee also reported progress on several projects including a preliminary specification for insulating fire bricks for furnaces with no atmosphere problems, a method of chemical analysis involving three silica refractory standards having different levels of alumina content, and a modification of the thermal spalling tests involving the changing of temperature variations during the rate of heating and other minor changes which will permit the temperatures on the panel faces to be more uniform. Seven laboratories are cooperating in the work of preparing a classification of silica brick. Revisions are under consideration in the Standard Classification of Fire Clay Refractories (C 27).

The committee is currently preparing a new manual on refractories which will include the existing refractory standards and industrial surveys reviewing the utilization of refractories in industry. The surveys in the present manual will be reviewed and revised where necessary and three new surveys will be added covering coke-oven refractories in soaking pits for steel ingots, refractories utilized in re-heating furnaces, and refractories used for annealing furnaces.

Manufactured Masonry Units

Additional coverage, as well as changes in existing standards, on both clay and concrete types of structural building units was reported at the meeting of Committee C-15. Proposed specifications on ceramic tower packings and for industrial floor brick were re-

viewed by subcommittee. The industrial floor brick specification was reviewed in connection with warpage and dimensional standards, and this proposed specification will now be submitted to all manufacturers for comment.

The existing standard specification for concrete masonry units has been under critical review for some time. A new method for measuring moisture content of these units, using a relative humidity method, will be recommended to the committee. Several procedures are under study for a shrinkage test method. The existing tentative revision of the Standard Methods of Sampling and Testing Concrete Masonary Units (C 140), which authorizes the use of either cement-gypsum capping or sulfur-filler capping, was approved for recommendation as standard.

The committee will consider terminology as one of its first approaches to the very difficult task of preparing standards on waterproofing materials. A test program is needed to establish the effectiveness of waterproofing materials in reducing the initial absorption of masonry units; and it was agreed that units as well as panels should be tested under moderate and severe conditions of exposure.

Thermal Insulating Materials

A long-needed method of sampling preformed thermal insulation was approved for letter ballot by Committee C-16. Other tentatives accepted for presentation to the Society cover specifications for cellular-glass thermal pipe insulation and mineral wool block (elevated temperatures).

A new method of test for wet adhesion of insulating cements to metals was accepted for letter ballot and the definition of finishing cement, as compared with insulating cement, was recommended as a tentative addition to the standard list of definitions (C 168).

A final draft of an emissivity test will also be submitted to letter ballot of the committee, together with the sixth and final draft of a hot surface performance test.

A proposed tentative method of test for water vapor transmission of building materials utilizing the Penn State-Armstrong Cell was approved for publication as information in the ASTM BULLETIN. This method is the result of extensive research conducted at Penn State University and sponsored by the Armstrong Cork Co.

Progress was reported in the newest field of activity—reflective insulation. A trial specification on reflective insulation will be prepared to solicit comments and suggestions.

Porcelain Enamel

A method for the thermal shock test of porcelain was proposed by Committee C-22 for publication as tentative and new areas of testing for porcelain enamels were initiated: gloss of porcelain enamel on curved surfaces, a method of testing the enamelability of enameling iron or steel, and the resistance of porcelain enamel to steam and condensate.

Measurement of gloss on flat surfaces is an essentially simple operation but gloss measurement of enamel-lined tanks and special shapes demands special procedures which are now under study. Enamelability of iron and steel is an important property; its measurement and parameters, however, are largely unknown. The committee in establishing work on enamelability is attempting to define a method which will provide a basis of purchase for a specification on enameling iron or steel.

Progress reports were also submitted on tests for coefficient of expansion, tearing, measurement of thickness, scratch, and staining.

Paint, Varnish, Lacquer

A highlight of the Committee D-1 meeting was a paper dealing with the preparation of magnesium for painting, presented by J. A. Stevens, Dow Chemical Co.

A proposed revision of the Tentative Method of Test for Flash Point of Volatile Flammable Materials by Tag Open-Cup Apparatus (D 1310) includes an improved calibration procedure and a few other minor changes. Method D 1310 applies only to determining the flash point of nonviscous materials.

Recommended for adoption as standard were tentative methods of test for:

- No-Dirt-Retention Time of Traffic Paint (D 1297)
- Settling Properties of Traffic Paints During Storage (D 1309)
- Phthalic Anhydride Content of Alkyd Resins and Esters Containing Other Dibasic Acids (Gravimetric) (D 1306)
- Phthalic Anhydride Content of Alkyd Resins and Esters Containing Other Dibasic Acids (Spectrophotometric) (D 1307)
- Apparent Free Phenols in Synthetic Phenolic Resins or Solutions Used for Coating Purposes (D 1312)

A new method has been developed for determining nonvolatile content of heat-unstable resin solutions. This will be incorporated in the Tentative Methods of Test for Nonvolatile Content of Resin Solutions (D 1259), which now cover solutions for heat-stable resins.

Two recommended practices for preparation of aluminum alloys for painting and for preparation of magnesium alloy surfaces for painting were submitted for publication this year.

New tentative methods for analysis of fatty acids, which cover procedures for acid value, saponification value, unsaponifiable matter, titer value, iodine value, and color were submitted along with the new tentative methods for sampling drying oils.

The Subcommittee on Varnish submitted a new Proposed Method for Rosin Acid Content of Varnishes. Consideration is being given to drafting in an ASTM form the Federal Test Methods for gas checking, draft test, qualitative test for rosin and ash in clear varnishes.

A proposed method for water fog test was submitted for publication as information, together with results of the cooperative tests to show the usefulness and limitations of the test.

The Subcommittee on Physical Properties submitted a new tentative method for measurement of dry film thickness of nonmetallic coatings applied on nonmagnetic bases.

The tentative method of test for Nonvolatile Matter in Lacquer Solvents and Diluents (D 1353) was recommended for adoption as standard. Test panels and synthetic perspiration test solutions as applied to testing lacquered surfaces have been prepared and sent to subcommittee members for study.

New tentative methods for chemical analysis of white titanium oxide pigments were submitted as tentative.

The new Subcommittee on Putty, Glazing and Caulking Compounds reported that its long-range program would encompass the following products of the industry: (1) glazing compounds for metal sash and wood sash, (2) caulking compounds, (3) putty for metal and wood sash, and (4) extruded type caulking compounds.

It was decided to proceed with the development of methods for knife-grade glazing compounds for metal sash. Four working groups were appointed to develop methods for performance tests on the following subjects: (1) accelerated weathering test in connection with properties of adhesion, flexibility, and ultimate appearance, (2) initial and ultimate set and surface drying, (3) slump, and (4) package stability and workability.

The committee has compiled a list of some 75 terms used in the industry which will be reviewed prior to publication.

(*Continued on page 40*)

Plating Symposium Draws Large Committee Week Audience

Properties, Tests and Performance of Electrodeposited Metallic Coatings Proves Timely Topic

Interest in the one-day Symposium on Properties, Tests, and Performance of Electrodeposited Metallic Coatings, was such that in spite of the many concurrent committee meetings, over 300 persons heard the papers.

The Symposium, bringing together at one time summaries of tests on coatings conducted over a period of years, outlined the role of Committee B-8 in a combined progress report and a report of work accomplished. The papers and the ensuing discussion pointed up areas in which further study can be conducted profitably.

The Symposium was opened by ASTM Vice-President R. A. Schatzel, Presiding at the two sessions were W. L. Pinner, Houdaille Industries, Inc., chairman of the Symposium, and R. J. McKay, a past chairman of Committee B-8. Brief abstracts of the individual papers follow.

Presiding officers and some of the men responsible for the highly successful Plating Symposium: Seated, left to right: Associate Executive Secretary R. E. Hess; Vice President R. A. Schatzel; Symposium Chairman W. L. Pinner. Standing: A. H. Du Rose; Glade Bowman; August Mendizza; William Blum and Committee Chairman C. H. Sample.

History of ASTM Committee B-8, by William Blum, National Bureau of Standards.

Dr. Blum, in his accustomed style, partly humorous and always scholarly, traced the history of Committee B-8 from 1927, when a testing committee on hardware performed some tests on pole hardware coated for outdoor exposure. Specifications for plated coatings were first prepared in 1935 through the joint efforts of ASTM Committees A-5 on Corrosion of Iron and Steel, B-3 on Corrosion of Non-Ferrous Metals, B-6 on Die-Cast Metals and the American Electroplaters Society's Research Committee. To simplify the function and action of this industry group, ASTM Committee B-8 was formed in 1941 to prepare specifications for electrodeposited coatings and to cooperate with the related ASTM committees and the AES. It has grown in size and importance and now includes 178 active members and 114 company members. Its organization includes five active subcommittees.

Corrosion Behavior and Protective Value of Copper-Nickel-Chromium and Nickel-Chromium Coatings on Steel, by C. H. Sample, International Nickel Co.

Mr. Sample reported exposure tests made over a period of years to compare the service of copper, nickel, and chromium plate on steel with that to be obtained from nickel and chromium on steel. The basic background and reason for the study was to determine the durability of plated coatings on auto bumpers and bumper guards and to establish the best thickness for various combinations of plate.

Results indicated that a 1.0 mil coating of nickel or of copper-plus-nickel did not furnish good protection in a marine atmosphere. A total thickness of 1.0 mil of nickel obtained by plating ½ mil of nickel, buffing the plate, and plating another ½ mil of nickel showed good resistance to salt corrosion.

Although on thin coatings the presence of copper seemed detrimental, samples plated to a total thickness of 3.0 mils appeared to be in good condition after 1½ yr exposure in a marine atmosphere. There seemed to be no difference in the protective value whether the samples were plated with 3.0 mils of nickel, 1.0 mil of copper, and 2.0 mils of nickel, or with 1½ mils of copper and 1½ mils of nickel.

Coatings made up of copper and nickel appeared to be superior to straight nickel coatings in an industrial atmosphere.

Salt-spray corrosion tests may be misleading if used to evaluate copper-nickel coatings because exposure tests in industrial atmospheres appear to give far different results. Generally, it would appear that all-nickel coatings are better than copper-nickel combinations, with double-nickel coatings far superior.

Evaluation of Methods Available for Measurement of Surface Luster of Electroplated Coatings, by Glade Bowman, Standard Steel Spring Div., Rockwell Spring & Axle Co.

The matter of measurement of surface luster has been the concern of

Subcommittee III, Section D, and this paper is a summary of progress made since 1948. Surface luster includes surface reflection and image reflection, and is an important consideration in the sale of consumer products.

Consumers have been educated to expect that plated articles with a high surface luster will perform satisfactorily.

Specifications for smoothness of a number of surfaces have been established as follows:

R—Surface roughness of 3 microinches
S—Surface roughness of 6 microinches
T—Surface roughness of 12 microinches
V—Surface roughness of 24 microinches

Steel panels were prepared for use in evaluating the profilometer, the photovolt photometer, the General Electric recording spectrophotometer, and the Brush surface analyzer. These instruments were used to rate samples by texture, scratches, over-all appearance, and visual appearance.

The tests conducted on a variety of surfaces prepared by a number of different methods and solutions showed that all the testing instruments give best results on a flat surface. However, measurements are not consistent when the different instruments are used to examine duplicate samples. No instrument can make exact measurements in all cases. Since most commercially plated products are shapes rather than flat surfaces, the appearance of the plated surface still depends a great deal on the skill of the inspector.

Recommended Practices for Cleaning Prior to Electroplating, by S. Spring, Pennsylvania Salt Mfg. Co.

Generally, it is recommended that where possible, cleaning be separated into a three-part process:

1. *Precleaning*—to remove the bulk of the soil.
2. *Intermediate cleaning*—to remove oily films.
3. *Electrocleaning*—to remove particles and other surface contaminants.

Since the greatest factor in successful cleaning is the surface soil, it is desirable to control the amount of soil on the surface, to avoid an excess of buffing compound, and to keep buffing wheels cool so that buffing compounds will not be "burned." If possible, buffed products should go to the cleaning department immediately, be dipped in hot water or given a preliminary cleaning cycle immediately after buffing.

Soak cleaners used prior to a final electrocleaner should be operated at a concentration of 4 to 8 oz per gal and from 180 F to boiling; spray cleaning at a much lower concentration and temperature; barrel or tumble cleaning at a lower temperature but a longer time, the concentration varying from 1 to 6 oz per gal.

Electrocleaning, which is unique to electroplating establishments, is used to remove the last traces of soil from the metal surface.

Comparison of the Corrosion Behavior and Protective Value of Electrodeposited Zinc and Cadmium Coatings on Steel, by C. H. Sample and R. B. Teel, International Nickel Co., and A. Mendizza, Bell Telephone Laboratories.

These tests compare the corrosion protection of zinc with that of cadmium on steel surfaces. The coatings were deposited from bright zinc and cadmium baths to thicknesses of $\frac{1}{2}$, $1\frac{1}{10}$, 0.2, 1.0, and 2.0 mils.

Tests were conducted in three environments:

1. Salt spray (3 and 20 per cent)
2. Actual sea-water spray
3. Cyclic temperature and humidity test

Cadmium appeared to have better resistance to the salt spray than zinc. However, after 64 and 500 hr in a sea-water spray, zinc appeared to have better corrosion resistance than cadmium. The humidity tests appear to indicate that cadmium is superior to zinc. Cadmium exposed in a New York atmosphere, however, rusted more quickly than zinc.

Other conclusions were:

1. Life of the coating (cadmium or zinc) depends on the test location.
2. Zinc and cadmium fail more rapidly in an industrial atmosphere than in a marine atmosphere.
3. Zinc lasts longer than cadmium in some industrial locations.
4. Cadmium shows up more favorably in salt-sprays tests.
5. It was difficult to correlate results obtained from salt-spray tests and exposure tests.
6. Zinc appeared to be less protective in humid conditions.
7. The relative protective value of zinc *versus* cadmium varies with conditions and cannot be predicted by accelerated corrosion tests.

Evaluation of Supplementary Coatings by R. E. Harr, Western Electric Co.

A series of tests to determine the protective value of conversion coatings on zinc and cadmium are in progress on the following:

1. Phosphate coatings on zinc
2. Chromate coatings on cadmium
3. Chromate coatings on zinc

The study will compare methods of measurement of the thickness and density of the phosphate coating on both acid and alkali zinc electroplates. Another investigator will evaluate 14 different chromate conversion processes as well as the specifications for each process. Samples will be tested, exposed in various geographical locations, and some will be prepared as couples. It is the object of this series to arrive at a better evaluation test.

Another series of tests compares the protective value of chromate coatings with that of plain zinc and the protective values of different types of chromate coatings. Preliminary tests indicate that chromate coatings (without subsequent paint coatings) in an industrial atmosphere do not extend the useful life of zinc coatings.

Atmospheric Exposure of Electroplated Lead Coatings on Steel, by A. H. DuRose, Harshaw Chemical Co.

Tests were made on coatings of lead plated on steel, tin-lead alloy, hot-dipped zinc, lead, and terne plate at four outdoor exposure sites. The samples were examined visually and weighed for steel loss; corrosion of steel was evaluated by a change in the tensile strength and corrosion of the lead itself by weight loss.

The lowest rate of lead corrosion was noted at the test site in New York City and the highest at Kure Beach, N. C. Pinholes through the lead coating were taken as first evidence of base metal corrosion. It appeared that lead is a good protective coating for steel until the lead is worn away to a thickness of 0.1 to 0.2 mil.

In comparison the lead appeared better than zinc at the New York City site. At other test sites, zinc appeared superior.

A copper flash prior to the lead plate was found to be beneficial. The tests seemed to indicate that the self-sealing action of lead corrosion products was of more importance than the sacrificial action of lead.

The Standard Salt Spray Test—Is It a Valid Acceptance Test? by A. Mendizza, Bell Telephone Laboratories.

The object of the work in evaluating the salt spray tests is to determine whether it is used intelligently and whether results are interpreted properly.

Averages of previously reported tests showed no correlation and a wide spread in test results. Even worse correlation was shown in the case of nickel-plated samples which had received a flash copper plate. There was no evidence of reproducibility in the samples examined and analyzed, even though the samples ostensibly were duplicates.

Statistical analysis indicated that the

various testing laboratories did not produce consistent results, and that the plated samples did not appear to be consistent, leading to the conclusion that the salt-spray test, as now practiced, lacks the qualifications of a standard test. To have a standard accelerated service test, uniformity in testing equipment must exist and standard samples must be available.

With the present system, there are too many variables for complete reproducibility.

Technical Committees

(*Continued from page 37*)

The Subcommittee on Latex and Emulsion Paints reviewed the results of the first round-robin on (1) wash) ability and scrubbability, (2) efflorescence, (3) freeze-thaw resistance, and (4-package stability.

A standard method for measuring ease of dispersion is needed as the apparent viscosity of latex paints is very sensitive.

Work is to be initiated on exterior test, bacterial contamination in the package and mildew growth on dried films, and the problem of coalescence or poor film formation.

Road and Paving Materials

Physical tests of compressed bituminous mixtures and bituminous-coated aggregates, together with the effect of water on these mixtures, have proved to be of greatest interest in the many fields of activity of Committee D-4, but the most difficult in the establishment of standard test methods for evaluation of their properties. Two well-known procedures for compressed mixtures will be published as information preliminary to further consideration: the Hveem test procedures and apparatus for determining cohesion and resistance to deformation, and for kneading compaction of laboratory samples. Cooperative tests on the reproducibility of both of these methods will be conducted. The Marshall test for stability and flow value of bituminous mixtures has been previously circulated to the committee and the comments are now under review. A method for the determination of moisture or volatile distillate in bituminous mixtures similar to the method published by the American Association of State Highway Officials (T-110-42), was accepted for letter ballot as a proposed ASTM tentative method.

New methods for determining the setting properties of bituminous emulsions are under study and reproducibility tests on the several methods included in ASTM Standard D 244 have been completed by six laboratories using six samples of emulsified asphalt. These data are now being studied preliminary to recommending changes in each of the test-method sections of the standard. A thin-film oven test developed by the Bureau of Public Roads and a micro-thin film test, developed by Shell Oil Co. are under consideration. Significant revisions pertaining particularly to new requirements for the needle, used in the ASTM standard method for penetration (D 5) are being considered to obtain better reproducibility. Cooperative tests will be conducted using the new needle types to establish sufficient data.

A proposed method of testing graded aggregate road mixes for certain water-soluble chlorides present as admixes was accepted for committee letter ballot. This method, under joint jurisdiction of Committees D-4 and D-18, has been approved by the latter committee.

Coal and Coke

In reviewing progress of its cooperative test program for a more efficient approach to the sampling of coal, committee D-5 reported that 15 tests are being made by 10 firms on each of several coal samples from the United States and Canada. The committee hopes this work will approach conclusion before the next meeting of the ISO Subcommittee on Sampling so that this organization will have the benefits of a system of sampling based upon the most advanced statistical approach. The available results presented at the meeting, though only partially complete, show good agreement and much more progress is expected at the Annual Meeting.

A report was received which reviewed all the current methods for determining storage and coal pile density, a long-standing problem in the industry. A study group is preparing a testing program in this field.

The study on the equilibrium-moisture problem is nearing completion, and it is expected that reports on this subject will be given at the Annual Meeting.

Paper

Revision of the method of test for titanium dioxide in paper was reviewed at the meeting of Committee D-6 in New York on February 23. The committee in recent months has been systematically considering all of its methods to ensure that they not only reflect the latest advances in paper technology but also to take into account any possibility of nonstandard variations in testing equipment. The following methods are being studied:

Method of Test for Basis Weight of Paper and Paper Products (D 646)
Method of Conditioning Paperboard, Fiberboard and Paperboard Containers for Testing (D 641)
Method of Conditioning Paper and Paper Products for Testing (D 685)
Method of Test for Tensile Breaking Strength of Paper and Paper Products (D 828)
Method of Test for Pinholes in Glassine and Other Greaseproof Papers (D 1221)

The committee has lately completed a paper-industry survey concerning use of the methods of Test for Ring Crush of Paperboard (D 1164) and for Flat Crush of Corrugated Paperboard (D 1225). The data obtained show definite trends in some respects to these crush tests and this material will provide the basis for revisions of these two standard methods.

Interest in a standard apparatus for testing corrugated mediums has caused the committee to consider work on such a test method. The report of existing mold-proof testing standards was presented for comment during the meeting. If enough interest is expressed in this subject it will become a project for future consideration.

Wood

The evaluation of wood preservative treatment has been the subject of research and development over a considerable number of years. The acceptance of a proposed ASTM method of test, known as the soil block method, subject to confirming letter ballot, was approved by Committee D-7, at its meeting in Chicago, on March 13. The soil block method was originated over 13 years ago at the Bell Telephone Laboratories, and research has been conducted since that time at the U. S. Forest Products Laboratory, at a number of universities, and in industry. It has received recognition in several foreign countries as well. This method will provide an accelerated means of evaluating the effect of wood preservatives, providing information in a two-week period that would normally require four months of actual weathering.

A very complete report was presented to the committee on the ASTM Wood Pole Research Program at the Forest Products Laboratory. In addition to four published progress reports, interim data reports have been made available to the members of Subcommittee VII on Wood Poles of Committee D-7, and to contributors, covering test data on untreated western larch, Douglas fir, and southern yellow pine poles. Three additional reports are now in the hands of the Technical Advisory Subcommittee for final review covering test data on lodgepole pine and western red cedar poles, and a comparison of test methods involving the crib *versus*

machine procedures. Poles have been selected and are in transit to the Forest Products Laboratory for tests on treated southern yellow pine. This represents the first of a series of tests of the final phase of the program dealing with the effect of preservatives on the strength of poles.

A number of other subcommittees reported activity in several fields. The latest draft of a revision of the Tentative Methods for Establishing Structural Grades of Lumber (D 245) is expected to be ready for consideration and action at the next meeting of the committee, this revision being the result of a study of the principles involved in the application of structural grading requirements. Considerable development is taking place in the field of laminated timber, and in the light of new research, it is expected that an extensive revision of the Standard Method of Test for Integrity of Glue Joints in Laminated Wood Products for Exterior Service (D 1101) will be made during the next year. The ASTM specifications and test methods on wood preservatives, all tentatives, were recommended for adoption as standard. The expansion of use, as well as the further development, of such modified wood and wood-base materials as Impreg and Compreg will result in considerable activity in the subcommittee concerned with these materials, and further recommendations are expected at the next meeting.

The need for a standard method for use in controlling moisture in timber has been under consideration for some time in the Subcommittee on Moisture Content. Although no standard method was proposed, the subcommittee reviewed existing methods involving the use of electric moisture meters and the oven method, which is not entirely satisfactory. The need was expressed for a nondestructive type of test procedure.

Preservative treatment of structural fiberboards against termite attack will be studied during the coming year by the Subcommittee on Fiberboard in cooperation with the Subcommittee on Durability and Exposure. A number of definitions of terms relating to structural fiberboards are now ready for review by a nomenclature subcommittee for ultimate presentation to the committee.

Bituminous Waterproofing and Roofing Materials

Coordination with other standards-writing organizations was emphasized at the meeting of Committee D-8 in line with the Society's policy of stressing, particularly, coordination with Federal specification agencies. A task group, appointed to make recommendations toward coordinating ASTM, Federal, and Underwriters' Laboratories specifications for asphalt shingles, presented for review a tabulation of the requirements of the specifications in easily comparable form.

A complete revision of Tentative Methods of Testing Asphalt Roll Roofing, Cap Sheets, and Shingles (D 228) was accepted for letter ballot of the committee. The revision includes modifications to determine total coating instead of coating soluble in carbon disulfide. The Subcommittee on Rheological Properties has been reorganized in order to consider better the general rheological concepts embodied in the several specifications under committee jurisdiction. Five task groups have been formed to deal with the following concepts: adhesion (including stickiness and tack), pliability (including brittleness), self-healing, cold flow (flow at low stress), and susceptibility.

Electrical Insulating Materials

With increasing emphasis on the needs of the electrical industry for classification of insulating materials based on performance and test rather than on definition, Committee D-9 which met February 13–15 in Philadelphia, has accelerated its program to develop suitable test methods to characterize the thermal capabilities of insulating materials which go into electrical equipment. Through cross-representation this committee is cooperating with the American Institute of Electrical Engineers in this effort. The committee is also actively engaged in the development of methods for testing the effects of corona discharge on electrical insulation. Groundwork was provided by a symposium on corona, held in the fall of 1955.

At the February meeting, the committee began work on development of tests for magnet wire insulation. The tests which this committee will develop will be useful in the national standardization work on magnet wire which is centered in ASA Sectional Committee C9 on which Committee D-9 is represented.

An outstanding feature of the committee meeting was a symposium on minimum property values of insulating materials. Often the minimum value for a particular property is the controlling factor in application of insulating materials. The papers outlined progress toward establishing these minimum levels for several important properties related to service conditions.

Closely related to the problem of minimum property levels is that relating to significance of tests. The committee has revised its previous recommendations related to significance and usefulness of tests and has submitted the new recommendations for publication by the Society.

Natural mica is one of the best dielectric materials known, and the committee is currently engaged in an intensive effort to improve the existing specifications for mica. New revisions of the mica specifications are currently

Meeting at Buffalo—Subcommittee on Latex Paint of Committee D-1 on Paint, Varnish and Lacquer.

The Synthetic Rubber Subcommittee of Committee D-11 on Rubber meeting during Committee Week.

being considered for recommendations to the Society, and publication of the revisions is expected within a few months.

Rubber

Committee D-11's "Glossary of Terms Relating to Rubber and Rubber-Like Materials" which has been five years in the making is now available. This Glossary, containing definitions of over 2300 terms on rubber and the various materials used in its manufacture, was compiled by a special committee.

Another outstanding accomplishment reported at the meeting was the completion of nine proposed methods for chemical analysis of synthetic elastomers covering procedures for determining: volatile matter by the hot mill method; volatile matter by the mill-oven method; total ash; water-soluble ash; carbon black in masterbatch; bound styrene in GR-S; organic acid; soap; and antioxidant by ultraviolet absorption of rubber solution and by ultraviolet absorption of rubber extract. New methods for synthetic latices (butadiene-styrene copolymers) were also completed.

These methods represent the standardization work completed by the committee to date on materials which had previously been an essential part of the Government Synthetic Rubber Program. With the transfer of the former Government facilities to private industry, the responsibility for the establishment of standards for use in synthetic rubber manufacture was given to Committee D-11.

The *Subcommittee on Hose* presented revised Specifications for Woven Jacketed Rubber-Lined Fire Hose for Public and Private Fire Department Use (D 296). These specifications apply to the trade sizes of $1\frac{1}{2}$, 2, and $2\frac{1}{2}$-in. single jacket and $1\frac{1}{2}$, 2, $2\frac{1}{2}$, 3, and $3\frac{1}{2}$-in. multiple jacket, rubber-lined fire hose suitable for use in public or private fire departments. They do not cover couplings nor the method of attachment.

The *Subcommittee on Insulating Tape* submitted for committee letter ballot revisions of the following: Specifications for Friction Tape for General Use for Electrical Purposes (D 69), Specifications for Rubber Insulating Tape (D 119), and Specifications for Ozone-Resistant Rubber Insulating Tape (D 1373). Also, new methods for use of the strain tester were submitted for submittee letter ballot.

The subject of ozone testing continues to be of primary importance, due to the fact that vulcanized rubber materials are subject to cracking when exposed under tension to air containing ozone in certain concentrations. A newly developed ozone test chamber was shown in a movie.

The *Subcommittee on Hardness, Set, and Creep* submitted for committee letter ballot a new Tentative Method for Hardness of Rubber based on the draft recommendation of ISO/TC 45 which is based on the use of the Wallace instrument. Experience with this instrument to date has shown that it is not suitable for use at low temperatures. The deficiencies are associated with the high frictional features inherent in the design.

The *Subcommittee on Flexing Tests* accepted a number of minor revisions in the Tentative Methods of Dynamic Testing for Ply Separation and Cracking of Rubber Products (D 430), and the Tentative Method of Test for Resistance of Vulcanized Rubber or Synthetic Elastomers to Crack Growth (D 813). These changes will bring the methods into agreement with certain proposals from the ISO Committee.

A report on results of round-robin tests by five laboratories on two compounds immersed in ASTM oils Nos. 1 and 3 at 250 F, 275 F, and 300 F, showed no significant difference between specimens aged in the oil bath *versus* aluminum-block oven. Based on these findings, a further study was made to evaluate possible effects of varying amounts of oxygen, water, and sulfur on high-temperature oil-aging of nitrile rubber stocks. Data were obtained from tensile strength and elongation tests made on dumbbell specimens cut from sheets of cured stock. These limited tests indicated that sulfur is definitely the major factor involved in the variablity of tension and elongation test results. The effect of oxygen or water alone was not significant, although their interactions may possess a significance. The low residual variance indicated that the factors being considered in this test are the principal ones involved in the variation of tension and elongation data. Further studies will be made.

In order to fill a need for a portable hardness tester for hard rubber, a method for durometer D hardness will be included in the Tentative Methods of Testing Hard Rubber Products (D 530). An impact test method for hard rubber now being developed will be adaptable to both test specimen and finished product testing and should minimize or eliminate the effect of "working" the specimen by repeated impact as in the existing falling-weight test. A further revision of Method D 530 will substitute a heat distortion test on unannealed specimens at 264-psi fiber stress, in accordance with the Tentative Method of Test for Heat Distortion Temperature of Plastics (D 648) for the present softening point test.

A paper surveying hardness instruments for testing rubber with particular reference to low-temperature operation will be presented at the committee meeting in June.

The *Subcommittee on Tests for Coated Fabrics* has developed an extensive program of work which will include studies of the following tests: bursting strength, scrub test, stitch-tear, cold cracking, flame resistance, and exposure testing.

Separate task groups will be appointed to proceed with studies on these several test methods. The personnel of the subcommittee has been enlarged to include representatives from other interested technical committees of the Society and also other associations having an interest in coated fabrics.

The *Subcommittee on Statistical Quality Control* presented a new tentative method for interlaboratory testing of rubber and rubber-like materials. Its purpose is to determine the variability in results caused by different personnel, equipment, and environment in following a prescribed method of test, and the consistency from sample to sample of this variability.

The *Subcommittee on Processibility Tests* submitted revisions of the following: Method of Test for Viscosity of Rubber and Rubber-Like Materials by the Shearing Disk Viscometer (D 927), Method of Test for Curing Characteristics of Vulcanizable Rubber Mixture During Heating by the Shearing Disk Viscometer (D 1077), and Methods of Test for Plasticity and Recovery of Rubber and Rubber-Like Materials by the Parallel Plate Plastometer (D 926) which were recommended for adoption as standard.

The new *Subcommittee on Compounding Ingredients* reviewed the results of the latest round-robin test for development of a set of test recipes for testing carbon blacks in rubber. A previous round-robin test had indicated that the test recipes (two based on natural rubber, and one based on GR-S) were satisfactory, except for the fact that at 60 parts loading of black, certain of the blacks gave very short breaking elongation in the stress-strain test. In the current round-robin test, the effects of reducing the carbon black loading to 45 and 40 parts were to be determined as well as the differences in results when mixing is accomplished in a Banbury or on a mill.

Soaps

Even a record-breaking snowstorm did not prevent some very successful meetings of Committee D-12 on March 19 and 20 in New York. Arrangements were set up for a number of new projects and for reactivation of work on others.

Of particular importance were the arrangements for activation of some 20 task groups to develop specific test procedures in the Joint Committee on Analysis of Soap and Synthetic Detergents recently organized by ASTM and the American Oil Chemists' Society. By providing for cooperative effort in the two societies, this group will expedite the preparation of up-to-date methods for analysis of soaps and synthetic detergents.

Provision also was made for greatly increased activity on performance tests for evaluation of detergency. These will include requirements for preparation of standard soiled samples, standard procedures for subjecting the samples to the action of the detergents under controlled conditions, and standard methods for evaluating the effectiveness of the detergents.

An important new procedure that will be recommended for publication as a revision of the Tentative Methods for Analysis of Sodium Triphosphate (D 501 – 55 T) is the method for determination of orthophosphate.

Industrial Aromatic Hydrocarbons

Data resulting from a cooperative test program for a proposed method of testing for thiophene was presented at the meeting of Committee C-16 as well as a revision of the Specifications for Industrial Grade of Benzene (D 836).

Progress reports were presented for the following cooperative programs: infrared ultraviolet determinations of xylene isomer distribution; analytical tests of pure benzene for pyridine, carbon disulfide content, total sulfur, and chlorine content; solidification point, color, ash, and acid wash test of naphthalene; water content and water solubility of refined phenol; and distillation and water content of refined pyridine and quinoline.

Interest in dodecylbenzene and its homologues has increased to a point that the committee has appointed a new subcommittee to cover this field.

Industrial Water

At Committee D-19's January meeting in Biloxi, Miss., major activity was concentrated on new and revised methods of tests, and plans were furthered for a new edition of the Manual on Industrial Water and for a group of papers to be presented at the Second Pacific Area Meeting in Los Angeles this September.

Three proposed tentative methods were approved for committee letter ballot. The method for determination of sodium and potassium by flame photometry represents the first use of this technique in a method prepared by the committee. The determination of ammonia and of hydrogen in industrial water is covered by the other two methods.

Two tentatives were recommended for adoption as standard: Specifications for Reagent Water (D 1193) and Method of Test for Oily Matter in Industrial Waste Water (D 1340). Other tentatives to be revised are Methods of Test for Acidity and Alkalinity in Industrial Water (D 1067) and for Silica in Industrial Water (D 859).

Among the new methods currently

Photographed during Committee Week were ASTM Director R. C. Alden, B. S. Garvey, Jr., and Past President A. W. Carpenter.

under development for testing industrial water are methods for copper, zinc, and lead. For industrial waste water, methods are being prepared to cover biochemical oxygen demand, taste and odor, and chlorine residual. The chlorine residual methods will be complementary to the present Methods of Test for Residual Chlorine in Industrial Water (D 1253).

Methods employing radioactive isotopes in the analysis of industrial water and industrial waste water and methods for measurement of radioactivity in water are being studied by the committee.

Work is continuing on methods for performance tests of ion exchange resins for use in the treatment of industrial water. Considerable progress was reported on a method for measuring the "operating capacity" of such resins.

As the preparations for a new edition of the "Manual for Industrial Water" have progressed, it has become evident that a major revision of the present chapters and the addition of new material will defer the publication date until late in 1957. Accordingly, the committee has recommended publication later this year of a third printing of the first edition, with the new and revised methods issued in 1955 and 1956 appended.

Plastics

The rapidly expanding markets for plastic pipe in a variety of applications have made the need for standard methods of test and specifications in this area acute. In Committee D-20 is centered the joint effort of ASTM and the Society of the Plastics Industry in establishing standards for plastic pipe. While no standards are yet ready for recommendation to the Society, a number are in process of development.

Markets for polyethylene are expanding at an exceedingly rapid rate and the improvement of existing specifications for polyethylene is complicated by the development in recent years of new types of polyethylene involving low-pressure polymerization and irradiation. These new polyethylenes have different and in many ways improved properties over those of the polyethylenes which have been on the market for some time. A number of names or designations for these different types of polyethlenes have been proposed leading to some confusion in the industry. Committee D-20 is actively dealing with this problem through its Subcommittee on Definitions, Nomenclature and Significance of Tests. Solution of the nomenclature problem for polyethylenes should greatly aid in the development of suitable specifications and methods of test for characterizing these materials. Progress on polyethylene specifications is proceeding apace.

A feature of the Committee D-20 meeting held in Philadelphia on February 15–17, was a session at which papers were presented on subjects including glass-fiber-reinforced plastics, a film toughness tester, and methods for determining Young's modulus in flexure.

Recognizing the importance of engineering materials, including plastics, in the industrial development of atomic power reactors, Committee D-20 established a group to study the effects of radiation on plastic materials. The group will work toward establishing recommended practices for exposure of plastics to radiation and uniform methods for evaluating the effects and and reporting the data. These efforts will be coordinated with other related activities in the Society.

Wax Polishes

Committee D-21 presented the following four new methods: (1) the determination of flash point for solvent type waxes, (2) method of test for water spotting of emulsion type floor waxes, (3) method of test for removability of water emulsion floor waxes, and (4) method of application of emulsion floor waxes.

Also submitted were progress reports on the proposed methods of determining hydrocarbon content of natural raw wax materials, insoluble impurities in natural waxes, and nonvolatile content (total solids) of solvent type waxes.

Revisions of Tentative Methods for Acid Number (Empirical) (D 1386) and for Saponification Number of Natural Waxes (D 1387) are being made on the basis of extensive cooperative work. It is expected that these revisions will simplify and permit faster operation of these methods.

A final report was made of the determination of the accuracy and usefulness of the Carnauba wax benzene solubility test. This report will be published in an early issue of the ASTM BULLETIN. The problem of sulfur in Carnauba wax discussed and a project to promulgate an analytical method on this subject was initiated.

Atmospheric Sampling and Analysis

Much in evidence in recent years, especially in industrial and population centers, is the increasingly serious problem of atmospheric pollution. ASTM is contributing toward the solution of air-pollution problems through its Committee D-22 which is actively engaged in the establishment of standard methods for analyzing the atmosphere for various pollutants and in the establishment of a standard terminology related to air-pollution control.

The committee acted to supply liaison and cooperation with a joint committee on fly-ash test standards, which has been organized under the auspices of the ASME. The collection and disposal of fly ash has long been a problem, particularly to the power industry. Other ASTM committees concerned with fly-ash problems are also represented on the ASME committee.

The committee will shortly recommend a number of definitions to be added to the Tentative Definitions of Terms (D 1356). Another active project is the development of a list of units and conversion factors used in air analysis. Work is about complete on a method for determining fluorides in the atmosphere which, it is anticipated, will be presented to the Society for publication this year. Efforts are going forward in developing methods for sampling gases and vapors, particulate matter, and for stack sampling.

New instrumental methods for continuous analysis of various pollutants are constantly being devised, and the committee is actively working on standardization of several of them. Instrumental methods under consideration include those for mass concentration of particulate matter by light scattering, and for particulate matter by optical density of filtered deposit.

Cellulose

The Advisory Subcommittee of Committee D-23 held an interim meeting in New York, N. Y., on February 22 at which time two proposed methods were presented for submission to Committee D-23 for the Annual Report: methods of testing sodium carboxymethylcellulose, and for pentosans in cellulose.

Several projects in various stages of completion were reviewed including method of test for color of cellulose, method of test for ash content of cellulose, method of cold alkali solubility, testing for functional groups, and moisture of cellulose.

A new group, appointed to study chromatographic methods of determining various constituents of cellulose and its derivatives, has begun the determination of pentosans by a newly proposed chromatographic procedure.

Work has also been started on a carbanilation method for the determination of hydroxyl radicals in cellulose acetate.

Since Committee D-23 holds its meetings in conjunction with the Cellulose Division of the American Chemical Chemical Society, the forthcoming symposium on new methods of testing cellulose which will be presented at the

September meeting of the American Chemical Society was reviewed. This symposium will contain approximately 15 papers including the following methods for testing cellulose and its derivatives: near-infrared spectroscopy, flame photometry, carbon-14 reagents in cellulose, isotope dilution, hydrolysis rates, nuclear magnetic resonance methods of determining moisture, and chromatographic procedures. The committee expects that many of these methods, though of a highly theoretical nature, will find eventual acceptance by industry and thus lend themselves to publication as standard methods in the future.

Carbon Black

From theatrical grease paint to auto tires, carbon black—product of the oil and gas industries—is a key material. It increases the strength and durability of rubber and provides pigmentation for a host of products including paint, printing ink, and carbon paper. With such versatility of uses it is no wonder that carbon black is supplied in a wide variety of forms and properties.

Recognizing the need for uniform methods of test for carbon black, an industry committee of producers has been working for several years to develop suitable test methods. These were brought to the attention of ASTM for consideration and since all ASTM standards for products used in commerce must have the approval of consumers and general interests, as well as producers, it was decided that a new ASTM committee on carbon black should be established.

ASTM Committee Week provided the time and place for a get-together of all interested parties to work out the organization of the new group to be designated ASTM Committee D-24 on Carbon Black. Important actions at the meeting were the approval of a scope of activities and the appointment of a nominating committee for officers.

The committee will hold its official organization meeting on the occasion of the Society's 1956 Annual Meeting in June. The new committee will effect liaison with other ASTM committees concerned with products in which carbon black is an important ingredient. In the meantime, the Society will publish as information, the test methods developed by the carbon black industry committee, in order to elicit comments for the benefit of the new committee.

Presiding at the meeting in Buffalo was R. C. Alden of Phillips Petroleum Co., a member of the ASTM Board of Directors. Mr. Alden had been designated by the Board to effect the organization of the committee. A. G. Cobbe of Cabot Carbon Co. is temporary secretary.

Methods of Testing

Committee E-1 announced plans for three symposiums at the Society's annual meeting in June, one on tension testing of nonmetallic materials, another on the subject of pH measurement, and the third on rheology.

Tension Testing.—A number of revisions to improve certain features of the general Methods of Tension Testing of Metallic Materials (E 8) were reviewed and approved for submission to the subcommittee for letter ballot. Since these methods are widely used in the tension testing of both ferrous and nonferrous metals, the committee decided to survey thoroughly any recommended changes. The proposed modifications now being voted on, are the result of experience with the methods since they were last revised in 1954 and are intended to introduce certain desirable refinements and clarifications.

Light and Electron Microscopy.—The Subcommittee on Microscopy received reports from three of its task groups. A new Task Group on Nomenclature and Definitions of Microscopes was formed under the chairmanship of H. F. McMurdie, National Bureau of Standards.

The Task Group on Bibliography is preparing a complete list of all methods appearing in ASTM standards and technical papers or symposiums. The bibliography will include a subject index with all items listed by title. There will also be a numeric index of the designations of ASTM standards and tentatives.

The Task Group on Photomicrographic Materials has under study some eight projects, five of which deal with interchange of principal parts of light microscopes and three with standardization of microscopical slides, cover glasses, and immersion media. The task group will be canvassed on three of these projects to be undertaken immediately.

The Task Group on Specifications for Photosensitive Materials is considering the qualities of emulsions, the use of film *versus* glass, and varieties of speed and contrast for light and electron microscopy.

A meeting discussing organization of a Carbon Black Committee during Committee Week.

Low-Temperature Testing.—The Subcommittee on Low-Temperature Testing of Elastomers and Plastics received a 54-page report on the study of rheological testing of elastomers at low temperatures. The report contains data from the cooperating laboratories as well as the fundamental factors involved in rheological testing. The report was approved for publication in the ASTM BULLETIN.

An extensive report was also presented on the statistical analysis of the hardness test data which showed good correlation of the Pusey & Jones and Shore A durometer, also the Pusey & Jones, and Rex hardness methods. Curves and conversion equations were distributed. Further studies are to be made of these data and a report presented at the June meeting.

Hardness Testing.—The Hardness Conversion Tables for Steel (Relationship Between Diamond Pyramid Hard-

ness, Rockwell Hardness, and Brinell Hardness) (E 48) will be thoroughly examined by a new task group. This project will include a re-study of the present hardness conversion values, particularly at the high hardness levels. Consideration will also be given to including tensile strength values in the tables. This work will be a cooperative effort of ASTM Committees E-1 and A-1 on Steel, representatives of the Society of Automotive Engineers, American Society for Metals, American Foundrymen's Society, the Armed Services (through the Arsenals), and manufacturers making parts of high-tensile strength steel for military aircraft.

Thickness Measurement.—The Subcommittee on Thickness Measurement reviewed a Procedure for Calibration of Spindle Pressure on Rachet Micrometers. Action was taken to submit this procedure to letter ballot for inclusion in the Standard Methods of Test for Thickness of Solid Electrical Insulation (D 374). This calibration method has been prepared after a round-robin study. It is believed that its use will prove valuable in checking and setting spindle pressures on rachet micrometers and that this will eliminate some of the difficulties that have been experienced.

Emission Spectroscopy

Meeting on February 29 in Pittsburgh, Pa., in connection with the Pittsburgh Conference on Analytical Chemistry and Applied Spectroscopy, Committee E-2 co-sponsored a Panel Discussion and Open Forum on X-ray Spectroscopy.

The committee also recommended publication as tentative of recommended practices for photographic photometry in spectrochemical analysis, based on the Suggested Practices E-2 SM 2-2 published in "Methods for Emission Spectrochemical Analysis." Also recommended for publication as tentative is a method for spectrochemical analysis of pig lead, based on the suggested method E-2 SM 6-3.

Work on a write-up of requirements for spectrographic apparatus was continued. A "Report on Standard Sizes and Shapes of Graphite Electrodes" and a "Report of Progress in Preparation of a Universal Method of Spectrochemical Analysis" were also approved for publication as information only.

Publication this year of a new Part IV of the "Index to Literature on Spectrochemical Analysis" was recommended. Preparation of material for this addition was reported nearly complete.

A program was set up for collecting information on standard samples in order to keep information more currently up to date. The 1955 edition of the "Report on Standard Samples and Related Materials for Spectrochemical Analysis" is expected to be available soon.

Fire Tests of Materials

The definition of the basic term "noncombustibility," which has proved to be unusually difficult, was further advanced by Committee E-5 by approving for publication in the ASTM BULLETIN as information only, a proposed method of test for defining the term. It is hoped thereby to secure comments from additional sources, which will benefit the committee in taking further action toward the acceptance of a standard by the Society.

A second draft of a proposed standard method of fire test applicable to various types of windows and glass blocks installed in exterior walls to serve as protection assemblies against the passage of flames will be prepared for review. Under way is a study of the degree of restraint of steel framing comparable to that found in buildings, to establish the need for a revision of the Standard Method E 119. A revision was approved in the new Tentative Method of Fire Test of Roof Coverings (E 109) which will clarify how temperatures are developed in the intermittent flame test. In reporting on the small tunnel test program at the Forest Products Laboratory, it was noted that promising results have been shown, with a final report to be available at the time of the Society's Annual Meeting in June.

Testing Building Constructions

Much interest was expressed in building construction testing standards at the well-attended meeting of Committee E-6. As a result of the last meeting of the committee and panel discussion during the 1955 Annual Meeting of the Society, a revision of the scope of the committee was approved, which will take cognizance of the interest of the committee in housing structures and of the desire to effect close liaison between building code authorities and ASTM in relation to their needs for standard test methods of building constructions.

New projects discussed for possible consideration included the whole subject of load tests upon completed structures, the testing of window assemblages, and the place of connections in structural testing.

Reorganization of the committee was completed, with the appointment of an Assistant Secretary in charge of membership, J. A. Thomson, National Bureau of Standards. More complete liaison with other ASTM technical committees has now been established, with representatives listed from 12 committees. These representatives, together with the officers of the committee, will form a planning subcommittee, which will be responsible for consideration of all new projects. One new project, under the chairmanship of Harry E. Plummer, Structural Clay Products Institute, is the preparation of test methods for determining the strength of masonry assemblages. This group will also be interested in reinforced brick masonry construction. A subcommittee will study the development of standard test methods for vapor-barrier materials for use other than as insulation alone; for example, vapor barriers used for covering crawl spaces beneath houses and for use under concrete foundation slabs placed on the ground. This work will be closely coordinated with the work of Committee C-16 on Thermal Insulating Materials.

Future activities include wall panel tests and durability testing and a symposium on the general subject of durability tests of building constructions.

Nondestructive Testing

At its meeting Committee E-7 reviewed the progress made on writing an up-to-date and detailed procedure for radiographic testing. The committee is looking toward publication by the Society of a new set of reference radiographs for bronze castings similar to the reference radiographs for steel castings of a few years ago. Further work is being done to fill the gaps in the present reference radiographs for steel welds and to furnish additional radiographs for types of welding and radiation which are not now covered.

Another task group is gathering information on the use of penetrant testing, which will eventually lead toward a new ASTM method.

Fatigue

Plans for a questionnaire designed to obtain information on current and future projects in fatigue research were formulated by Committee E-9. Scheduled for completion in June, the questionnaire will be distributed to some 300 Government agencies, university, industrial, and commercial laboratories.

The primary objectives of the committee in conducting this survey are: (1) to prepare ultimately a list of all fatigue projects now in progress in the principal laboratories in the United States and Canada, (2) to compile a list of fatigue topics on which further information is desired, and (3) to get information on laboratories willing to undertake commercial testing and their facilities for doing so. Resulting infor-

mation will be published for general circulation.

A similar project undertaken by Committee E-9 in 1950 was widely received and aided considerably in coordinating information on activities in the field of fatigue research.

Radioactive Isotopes

The Society's Special Administrative Committee on Nuclear Problems has asked Committee E-10 to consider an extension of activities to develop basic methods for evaluating radiation-induced changes in materials.

With this in view, the committee voted to change its title to Committee E-10 on Radioisotopes and Radiation Effects and to revise its scope subject to the approval of the entire committee and of the Board of Directors of the Society.

The subcommittees are being asked to prepare bibliographies of the information generally available in literature on the subjects falling within their scope. One of these will cover changes in materials induced by radiation. The present plan is to circulate this bibliography, appropriately subdivided, so that the other technical committees of the Society can be apprised of work which has been done in their fields.

Committee E-10 will hold its next meeting in Los Angeles during the ASTM 2nd Pacific Area National Meeting in September. At that time, the committee will sponsor a symposium of approximately 10 papers concerned with test methods using radioisotopes, as well as two papers discussing possibilities of specifications for irradiated organic materials and metals.

Also at Los Angeles, the Joint Atomic Industrial Forum-ASTM Symposium on Radiation Effects on Materials will be presented. This will contain about 14 papers of unclassified data on irradiated materials.

Absorption Spectroscopy

At its February meeting in Pittsburgh, held in connection with the Pittsburgh Conference on Analytical Chemistry and Applied Spectroscopy, Committee E-13 reported progress in the preparation of methods of measuring the more significant parameters for evaluation of spectrophotometers for use in methods of analysis by infrared and ultraviolet spectroscopy. A draft of these methods is nearly ready for review and approval by the committee. They will make possible the description of infrared and ultraviolet apparatus in test methods in terms of significant parameters and will provide means for determining compliance of the apparatus with the specified requirements.

Considerable progress also was made in the preparation of uniform formats and nomenclature for methods of analysis by infrared and ultraviolet spectroscopy. Committee E-13 is arranging for liaison with other committees wherever infrared and ultraviolet methods are being written.

Arrangements were made to streamline and expedite the work on standard data—particularly on the decks of punched IBM cards indexing infrared and ultraviolet absorption spectra. A deck of empirical formula name cards covering the ultraviolet spectra now included in the punched card index is now available and will provide a means of locating the sources of published ultraviolet spectra where only the empirical formula or name of a compound is known. This will complement the empirical formula deck which already has been published to cover the infrared spectra.

Materials for Electron Tubes and Semiconductor Devices

With the rapid commercialization of transistors and other related semiconductor devices in recent years, the need for establishing standards for the materials used in them has become increasingly evident. The work of Committee F-1 on Materials for Electron Tubes and Semiconductor Devices in establishing standards for semiconductor materials such as germanium and silicon, initiated at the Annual Meeting of the Society in 1955, was continued at a meeting of the committee held in New York on February 16 and 17, 1956. Present efforts are concentrated on germanium metal and its oxides, and intensive effort on the evaluation of various existing methods is in progress. It is expected that when standards for these materials have been developed and are made generally available the result will be a great improvement in the uniformity and reliability of these important electronic devices.

Another important activity of the committee, begun in 1955, was the effort to establish standards for luminescent materials, for which a large consumer is the television picture-tube industry.

With the great interest and diligent work evidenced by these new groups, it is expected that there may be some recommendations for action by the Society in the not-too-distant future.

One of the important activities in the area of standards for electron-tube materials is referred to as the Cathode Nickel Melt Program which is a continuing effort. Cooperating with the committee in this work are the International Nickel Co. and the National Bureau of Standards.

Most of the electron tube work of this committee has been on problems associated with ordinary receiving tubes, although in many cases the standards developed have been applicable to more specialized tubes. Recognizing the unusual problems associated with some of the special purpose tubes, the committee has established a new group to evaluate some of the material used in pulsed and high voltage tubes.

Corrosion

At its meeting, the Advisory Committee on Corrosion decided to establish another exposure site in the New York area because of the proximity of a heliport on the roof of the Port Authority Building, the present site. The new location will be on the grounds of the U. S. Steel Supply Division in Newark, N. J.

The Key West test site has been vandalized to such an extent that it will be discontinued. Controversy over the years as to whether the Key West site should be typed as a strictly marine atmosphere resulted in a report which will appear in an early issue of the ASTM BULLETIN reclassifying the site from "marine" to "rural (marine)."

One of the newer committees represented on the Advisory Committee on Corrosion has already made preliminary plans to evaluate the corrosion resistance of malleable irons. It is hoped that this program will reach the exposure stage sometime in the fall of this year.

Fifty Papers on Mass Spectrometry at E-14 Meeting in May

AT A five-day meeting of ASTM Committee E-14 on Mass Spectrometry May 28 to June 1 at the Netherland Plaza Hotel, Cincinnati, Ohio, more than fifty papers, on all phases of mass spectrometry, will be presented at eight sessions. These papers sessions are open to all.

Business meetings of Committee E-14 and its subcommittees will be held May 28, 29, and 30.

Requests for a detailed program of the meetings, including the papers scheduled, should be addressed to William Priestley, Jr., Esso Research and Engineering Co., P.O. Box 121, Linden, N. J.

Activities of Committee D-2, June, 1954, to June, 1956—a Summary

This outline presents a summary of the work of Committee D-2 on Petroleum Products and Lubricants from June, 1954, to June, 1955, and a look ahead in 1956. The material is divided into a General Section and sections on Engine Fuels, Lubricants, Other Products, Measurement and Sampling, and Analytical Methods.

General

In 1955, Committee D-2 held its fiftieth birthday, which marked a half-century of service to users and producers of petroleum products by providing a meeting ground for standardization activities.

Committee D-2 is responsible for 78 Standards and 63 Tentatives, or a total of 141. These are published annually by the Society in a special compilation, comprising 990 pages. This is the largest compilation published by the Society of standards in a particular materials field. The number of copies printed each year also is much greater than that of similar compilations.

Three years of cooperative work by nearly all of the subcommittees and a special Editorial Committee will be culminated in 1956, with the publication of a completely revised and enlarged edition of the book "Significance of ASTM Methods of Test for Petroleum Products."

Since June of 1954 24 new members have joined the committee. New foreign members include the Bureau de Normalisation du Petrole, France; Fachausschuss Mineralöl und Brennstoffnormung, Germany; and the Associated Ethyl Corp., Ltd., England.

Liaison with the Federal Government by representatives of Committee D-2 is continuing. Mutual contacts have resulted in a decision to no longer duplicate ASTM methods in federal standard 791.

Remaining differences between ASTM methods and closely similar methods used in the Federal Standard VV-L-791 will be reviewed and recommendations developed to resolve them.

Engine Fuels

Technical Committee A on Gasoline *H. M. Smith, chairman.*

Review of the 1954–1955 Winter Motor Gasoline Survey resulted in a change in the octane numbers specified in ASTM Specifications for Gasoline (D 439). Research octane numbers for regular and premium gasolines were raised. Maximum vapor-pressure limits were also increased for summer gasoline.

The Coordinating Research Council, Inc., was requested to help in the development of methods for predicting vapor pressure of gasoline.

Recent rapid advances in the antiknock quality of motor gasolines has resulted in the consideration of an extension of the present octane number scale to include motor gasolines of over 100 octane number. Discussion and review of what is required are taking place in the committee, in the Coordinating Research Council, and in Research Division I on Combustion Characteristics.

A Symposium on Vapor Phase Oxidation of Gasoline will be sponsored by Committee D-2 in conjunction with the National meeting in Los Angeles, in September, 1956. Plans are being developed by Section III on Gum and Varnish. W. R. Power is chairman of the Symposium committee. Five papers will feature discussion of induction system deposits, deposit-forming characteristics of future fuels, antioxidants, and induction system reactions.

Developments in the CRC to provide information leading to new methods for predicting the storage stability of motor gasoline are being followed very closely.

Technical Committee J on Aviation Fuels *J. T. Hendren, chairman.*

The group continues to study Specifications for Aviation Gasolines (D 910) in recognition of the need for up-to-date specifications for fuels used in piston engines. Glass color standards for the five grades of aviation gasolines specified in Specifications D 910 are being considered as a replacement for the present color standards made of water-soluble dyes. The need for a test method to determine contaminants, such as kerosine, diesel fuel, and fuel oil, in aviation gasoline resulted in a request for Research Division V on Analysis of Fuels to work on development of a suitable test.

Section VII on Jet Fuels has started work on improved flammability and autogenous ignition tests for jet fuels.

Since jet fuels are filtered before they are used, a test method for filterability is being investigated. The method will be designed to detect the presence of finely divided solid contaminants in jet fuels and their effect on filters.

Use of civilian turbine-powered aircraft has resulted in the consideration of commercial specifications for jet fuels. Work is in the preliminary stage.

Technical Committee F on Diesel Fuels *W. K. Simpson, chairman.*

Papers presented at the Symposium on Diesel Fuels, held February 17, 1954, in Philadelphia, were published by the Society as *STP No. 167*.

The main work of the committee has been toward reaching consensus on revisions for the Classification of Diesel Fuel Oils (D 975). Several alternate classifications have been suggested. Work will continue until a classification is developed that is suitable to all interested parties.

Research Division I on Combustion Characteristics *F. C. Burk, chairman.*

The regular work of the Division, maintenance and improvement of the five ASTM engine test methods D 357, D 613, D 614, D 908, and D 909, results in a varied and active program in which 280 laboratories and more than 500 persons participate.

Research Method for Knock Characteristics of Motor Fuels (D 908), was revised by including a "temperature-density concept" which corrects variation in ratings caused by differences in barometric pressure at altitudes other than sea level.

One of the benefits of continued study and improvement of the ASTM engine test methods is increased precision of the test results. In January, 1955, an article, "Precision of Fuel Ratings 1947 to 1953," appeared in the ASTM BULLETIN. Factors leading to further increases in the precision of ratings are receiving attention through projects on improved test equipment, instrumentation, and reference fuels.

An improved instrumentation for the Cetane Method D 613 has been approved by Technical Committee F on

Diesel Fuels and the Division and will be considered by Committee D-2 in 1956. The new instrumentation involves the use of the ignition delay meter in place of the present combustion indicator.

The Motor and Research Methods, D 357 and D 908, and supplementary material will be published as a separate volume. Similar manuals, containing (*a*) Aviation and Supercharge Methods, and (*b*) Cetane Method, also with appropriate supplementary information, are being reviewed prior to publication at a later date.

Liaison with the Institute of Petroleum (London) is being maintained to further international standardization in the field of knock testing.

Concrete evidence of the success of efforts to achieve international acceptance of the ASTM engine test method was given by Technical Committee 28 of the International Organization for Standardization (ISO). This committee met in London in June, 1955, and agreed to submit the Motor and Research methods (D 357, D 908) to the ISO for consideration as international standards. (The United States is represented in ISO through the American Standards Assn. Both methods D 357 and D 908 are American Standards.)

Research Division V on Analysis of Fuels *C. A. Neusbaum, chairman.*

Much of the work of the committee is developing as a result of requests from Technical Committee J on Aviation Fuels. Two test methods are being discussed: (1) methods for detecting other liquid fuels contaminating aviation gasoline, and (2) a method to evaluate the effect on filtering systems of finely divided solid contaminants in jet fuels.

Research Division VIII on Volatility *R. J. Askevold, chairman.*

Work has continued on the preparation of a distillation procedure using a distillation flask of approximately 125 ml. The procedure would apply to all products now covered by methods D 86, D 216, and D 158. Final development of the 125-ml flask procedure will depend on whether an accurate single thermometer can be made available for the wide range of temperatures now being measured by ASTM Thermometers 7F and 8F.

Flash point methods D 56 (Tag Closed Tester), D 92 (Cleveland Open Cup), and D 93 (Pensky-Martens Closed Tester) are being revised. Emphasis has been placed on an examination of the precision sections of the methods, and cooperative tests have been run to collect new data. The new data will corroborate or change the precision statements.

Minor revisions for clarification have been made in vapor pressure Method D 323. Method for Vapor Pressure of Liquefied Petroleum Gases (D 1267), was adopted as standard. Further changes and refinements in both methods are receiving attention. They include, for Method D 323, a review of a null-point indicator as a substitute for Bourdon-type gages, and a study of the effects of air-chamber temperature and air saturation of the sample on results. For Method 1267, a vapor-pressure temperature conversion chart is under consideration. Cooperation with the Institute of Petroleum (London) will be maintained on details of procedure and apparatus.

Method for Reduced-Pressure Distillation of Petroleum Products (D 1160) is being reviewed with emphasis on equipment changes to improve precision of results.

Research Division X on Corrosion Tests *F. D. Tuemmler, chairman*

Copper Corrosion by Petroleum Products (D 130) was revised to clarify the interpretation of the colors of test strips and the use of the ASTM Copper Corrosion Standards, which were made available late in 1954. In addition, an improved design of the copper strip corrosion test bomb was included.

A second cooperative test program on humidity cabinet tests revealed that the level of test results is not significantly affected by the method of preparing metal test strips. Current plans involve a third program to evaluate variables in the operation of the humidity cabinet itself. These test programs are directed toward the eventual development of a reproducible ASTM test for operation of humidity cabinets.

Research Division XI on Calorimetry *A. J. Kramer, chairman.*

Work on methods for heat of combustion of petroleum products resulted in the publication as information of an indirect method for estimating heat of combustion. Progress has been made in the revision of Method for Heat of Combustion of Liquids by Bomb Calorimeter (D 240). If plans develop as expected, a final revision will be presented to the Society in 1956.

Lubricants

Technical Committee B on Lubricating Oils *W. S. James, chairman.*

Two symposiums are being arranged. A Symposium on Viscosity-Index Systems was held on February 7, 1956, in Dallas. Research Division III will cosponsor an ASTM Symposium on Trends in Lubricating Oil and Its Analysis, which will be held in September, 1956, in Los Angeles.

Work has continued on the development of a viscosity classification system for industrial lubricants. Two possible systems have been devised but neither has been selected. Divergent views are being reviewed by a special subsection.

The program on instrument oils resulted in the publication as information of a method of test for galvanic corrosion.

Considerable effort has gone into development of a reproducible test for the lubricating properties of railway car journal oils. Attempts to reproduce test results using standard reference car-journal oils in the Falex tester were not promising. Work will continue.

Liaison with the American Petroleum Institute's Lubrication Committee is being continued with respect to the Internal Combustion Engine Service Classification for Lubricating Oils, first issued by API in 1952, and under review since. The review has produced a revised classification which will be issued in 1956.

Technical Committee C on Turbine Oils *G. V. Browning, chairman*

Work is being done on a broad program concerned with turbine oils and associated equipment. Oil systems, and problems of rusting, oxidation, emulsion, compatibility, and fire resistance are receiving attention.

The ASME will publish a recommended practice for the design of turbine lubricating systems (2000 kw or over). Work is well along on the preparation of a similar recommended practice for smaller systems, under 2000 kw.

In 1956 a short-time oxidation test for turbine oils will be published as information. Publication will represent the results of several year's work to develop a less time-consuming oxidation test that is reliable and requires relatively simple equipment.

It is expected that an improved emulsion test for turbine oils will be available for Society consideration in June.

The test program on compatibility of turbine oils has been expanded. Preliminary data will be examined during 1956.

A special study group is developing information on fire hazards in turbine lubricating systems. During the year, interest in flammability and fire resistance has arisen in other Technical Committees of Committee D-2—Technical Committee J on Aviation Fuels and Technical Committee N on Hydraulic Fluids. Liaison will be main-

tained with these committees to coordinate any work.

Technical Committee G on Lubricating Grease *J. M. Bryant, chairman*

A wide-range program is continuing that is designed to provide test methods and information on the physical, chemical, and functional properties of lubricating grease.

In February, 1955, a Symposium on Shear Stability of Lubricating Greases was held in Houston. Nineteen short papers were presented. Several of the papers have been published by the National Lubricating Grease Institute in the *Spokesman*. Two methods of test were published as information by the ASTM: Consistency of Semi-fluid Greases, and Estimation of Harmful Particles in Lubricating Grease.

Methods for Effect of Grease on Copper (D 1261) and Lead in New and Used Greases (D 1262) were adopted as standards.

Technical Committee K on Cutting Fluids *R. F. McKibben, chairman*

The committee has been working for several years with the objective of providing methods of test, both laboratory and full-scale, to measure the effectiveness of cutting fluids, and to analyze their constituents. In February, 1956, in Dallas, the committee sponsored a panel discussion on methods of evaluating cutting fluids. Four possible test methods were discussed: a new performance test for cutting fluids; the critical rake angle method of evaluating cutting fluids; evaluation of cutting fluids by measurement of increase in feed load; and radioactive tool wear method for evaluating cutting fluid performance.

A report on and test method for the emulsion stability of soluble cutting oils was published as information.

Flank wear and finish methods for evaluating cutting fluids continue to receive attention, as does the laboratory film-strength test.

A program has been organized to evaluate cutting fluids in full-scale industrial applications.

Technical Committee N on Hydraulic Fluids *H. F. King, chairman*

As a result of a conference held in June, 1955, it was decided to place work on hydraulic fluids under the jurisdiction of Committee D-2.

Subsequently, the newest Technical Committee in Committee D-2, Technical Committee N on Hydraulic Fluids, was organized. H. F. King, Bureau of Ships, was appointed chairman; L. W. Manley, Socony Mobil Laboratories, Inc., vice-chairman; and W. H. Millett, Carbide and Carbon Chemicals Co., secretary. The scope of the committee will encompass methods of test, specifications, and nomenclature for hydraulic fluids, and the promotion of knowledge of the properties thereof.

Research Division VI on Analysis of Lubricants *J. B. Rather, chairman*

During the year the indicator specified in Method D 974, Neutralization Value by Color Indicator Titration, was changed to *p*-naphtholbenzein because of better results by its use. Cooperative tests will be run to develop suitable data so that the precision section can be expressed in accordance with the Recommended Form for Petroleum Methods.

Methods for determining insolubles in new oils containing residual stocks were studied. Cooperation with the Association of American Railroads will be initiated with respect to methods for determining insolubles in railway car journal oils.

Consideration will be given to the preparation of a procedure for the determination of the carbon residue content of petroleum oils with high-carbon residue values.

Research Division VII on Flow Properties *J. C. Geniesse, chairman*

The division completed one of its most active years. New expanded Viscosity Index Tables were published by the Society as *STP No. 168*. These V. I. Tables are based on the value for the viscosity of water put into effect by the National Bureau of Standards on July 1, 1953. This finishes the program, started in early 1952, to align the ASTM viscosity methods, tables, and charts with the new value.

Cooperative testing has been completed of two non-Newtonian test oils for their tendency to undergo permanent viscosity losses incurred when high shearing stresses are imposed. A report of this work entitled, "Determination of the Shear Stability of Non-Newtonian Liquids," by N. D. Lawson, has been published as a *STP 182*.

Development of a stable pour point test is continuing, as is the program to prepare a pumpability test for heavy fuel oils that can replace the cloud and pour test. The latter program is expected to result in a method to give numerical data for calculating flow discharge in the field for engineering purposes.

Research Division IX on Color *H. M. Hancock, chairman*

During the past year, this division prepared a Proposed Method of Test for Measuring the Color of Petroleum Products (ASTM Color Scale) which was published as information and will be offered as a successor to Method for Color of Lubricating Oil and Petrolatum by Means of the ASTM Union Colorimeter (D 155). The most significant improvement in the method is that the glass color standards are expressed in fundamental terms and are of proper chromaticity. During the coming year members of the division will cooperatively test sets of glass color standards which have been produced in accordance with the specifications of the method.

Subcommittee on Extreme Pressure Properties Measurement *P. A. Assiff, chairman*

The work since June, 1954, has included a cooperative program to determine the effect of surface-finish factors and machine condition on load-carrying capacity. The statistical data from this program are being evaluated at the present time. All data on liquid standards are being organized with the objective of publication of pertinent results in the ASTM BULLETIN.

The committee has done additional work on the formulation of a definition for load-carrying capacity. Preliminary investigations have been started on the effect of loading rate on extreme-pressure values obtained, and on the use of the same surface for all loads. This work should be completed within the next year.

Research Division XII on Graphite Tests *H. J. Dawe, chairman*

The division continued its program to provide methods of test for sampling and analysis of lubricating graphites. Proposed nomenclature and definitions for graphites have been submitted to the Coordinating Division on Nomenclature. Proposed methods for chemical analysis of graphite were published as information. Method for Lubricating Qualities of Graphites (D 1367) was published as tentative. Cooperative programs on sampling and sieve analysis are in progress.

Other Products

Committee D-2 maintains an interest in the development of standard methods of test for petroleum products other than fuels and lubricants. A few of these are: liquefied petroleum gas, butadiene, wax, petrolatum, petroleum sulfonates, plant spray oils, and signal oils. The Technical Committees on Light Hydrocarbons and Petroleum Wax were active, and some of their work is reported below.

Technical Committee H on Light Hydrocarbons *C. W. Ricker, Jr., chairman*

The main work of the committee consists of the review and maintenance of test methods for butadiene and other pure hydrocarbons and the development of test methods for liquefied petroleum gas.

The following activities are in progress:

1. Re-examination, with augmented representation, of the standards applicable to butadiene.
2. Consideration of methods for specific gravity and corrosion of liquefied petroleum gas, and wetness of propanes for ASTM adoption.
3. Assistance to other Committee D-2 groups in consideration of further features of standards applicable to light hydrocarbons.

Technical Committee M on Petroleum Wax *G. G. Rumberger, chairman*

Technical Committee M functions as a joint committee with the Technical Association of the Pulp and Paper Industry (TAPPI).

Since 1952 the committee has investigated methods of test to measure the physical and functional properties of wax and wax coatings. The work program has already produced two ASTM-TAPPI Methods, Tensile Strength of Paraffin Wax (D 1320) and D 1321, Needle Penetration of Petroleum Waxes (D 1321). Two additional methods—blocking point and oxidation stability—were published as information.

Mold release agents for the tensile-strength test are being considered. A cooperative program will evaluate the effectiveness of the agents.

A modulus of rupture procedure for waxes is being evaluated. Variables such as a coating for test specimens and rate of cooling are receiving attention. The work will continue until test reproducibility shows improvement.

A questionnaire indicated that interest in penetration tests in the region of 50 to 150 penetration is sufficient to warrant further work. Several methods will be considered.

Oxidation and other stability tests for waxes are the subject of work. Samples of inhibited and uninhibited paraffin and microcrystalline waxes and wax mixtures will be evaluated by the procedures. Improvement in test precision is being sought.

Development of an odor test for waxes has reached an advanced stage. Continued progress should produce an ASTM and TAPPI method within the next year.

Work is being done on a method to predict the strength of wax seals. Variables such as thickness of the wax and its location; and the amount of wax and its surface are being studied.

TAPPI has approved a research project on the development of an instrument and associated method to measure the gloss of waxed paper and to correlate the measurements with visual measurements.

Measurement and Sampling

Research Division II on Measurement and Sampling *C. A. Neusbaum, chairman.*

All sections of the division are busy on a schedule of activities designed to provide better methods of measuring and sampling petroleum products.

Methods for gaging, gravity determination, temperature measurement, and sampling are being considered. Procedures for calibrating tanks and new measurement tables are also receiving attention.

Work on gaging includes review and study of automatic gaging devices and methods for gaging spheres containing liquefied petroleum gas. Procedures for gaging pressure tanks on barges and containers blanketed with microballoons are on the program.

The precision of ASTM Gravity Methods D 1298 and D 287 for products lighter than 60° A.P.I., and NGAA Method 2140–55 for specific gravity are being reviewed.

Revisions of Method for Temperature Measurement (D 1086) will be proposed in June. Magnetic-lock bi-metallic thermometers and electrical-resistance thermometers continue to be evaluated.

The ASTM-IP Petroleum Measurement Tables (ASTM D 1250; IP 200) are constantly being reviewed. An indication of the stature these tables have attained since publication was given in June, 1955, when ISO Technical Committee 28 unanimously recommended that the tables be considered by ISO as an international standard.

During the year extensions to volume correction Tables 6 and 7 were approved. The extensions cover low temperatures from 0 to −50 F. Extensions to cover temperatures above 150 F will be proposed.

A new Table 34, Reduction of Volume to 60 F Against Specific Gravity 60/60 F for Liquefied Petroleum Gases, has been approved and is being published. This table will replace the present Table 32.

Supplementary tables for other products such as petrochemicals and waxes, and further extensions of existing tables are being studied.

The division has continued its very active program to prepare standard procedures for calibrating containers used in the storage and transport of petroleum products. Procedures for calibrating spheres and spheroids were approved. They supplement the already available standard for calibrating upright tanks, D 1220.

Also, a method for calibrating stationary, horizontal tanks has been prepared and will be submitted to the Society in 1956. Further work includes procedures for calibrating ship and barge tanks, a study of thermal effects on calibration measurements, and a review of the calibration characteristics of glass-reinforced plastic bolted tanks.

Work on sampling petroleum products resulted in a Symposium on Automatic Sampling Devices, held on February 8, 1956, in Dallas, Tex. J. H. Berglund, Secretary of Division II, was the developer of the symposium.

Method for Water and Sediment in Petroleum Products and Other Bituminous Materials (D 96) is receiving attention. The possibility of separating the method into two methods, one for crude oil and the other for petroleum products, is being considered. The specifications for the pear-shaped centrifuge tube are being studied. Changes may be proposed.

Analytical Methods

The development of standard procedures to determine the type and quantity of the constituents in petroleum products has received a great deal of attention in Committee D-2. Most of the analytical work is being carried out in two large Research Divisions: III on Elemental Analysis, and IV on Hydrocarbon Analysis.

Research Division III on Elemental Analysis *C. M. Gambrill, chairman.*

Research Division III is continuing its broad program to provide ASTM standards for the analysis of metallic and nonmetallic elements in petroleum products. Programs for determination of sulfur, chlorine, phosphorus, metals in lubricants, metals in fuels, tetraethyllead, carbon, hydrogen, oxygen, nitrogen, and metallic residues continue to provide new information and data leading to the revision of existing ASTM methods. Sulfur Methods D 90 and D 1266 were revised to include a special burner which enables sulfur to be determined in aromatic concentrates. A cooperative testing program is under way for the purpose of providing information that will enable the precision sections of the methods to be expressed in accordance with the Recommended Form for Petroleum Methods. An investigation of high-temperature combus-

tion methods for the determination of sulfur is planned.

The method for the determination of chlorine in lubricating oils by the sodium alcoholate procedure (D 1317) is being reviewed in order to determine whether or not the method should be continued as an ASTM standard.

A questionnaire to Technical Committee B on Lubricating Oils revealed a high level of interest in the Division's program to provide rapid direct methods for determining barium, calcium, and zinc in lubricating oil additives. Study groups have been organized to review methods for the polarographic determination of zinc, and flame photometric methods for calcium and barium. In 1956, it is planned to publish as information a polarographic method for determination of zinc. If work in the study groups proceeds as planned, proposed methods for the determination of barium and calcium by flame photometer will be available by 1957.

Methods for determining elements in fuel are receiving detailed attention. A report summarizing work on spectrographic methods for sodium and vanadium in residual fuel oils was published in the ASTM BULLETIN. The method for sodium in residual fuel oil (D 1318) is being reviewed. Revisions and extensions may be proposed in the near future.

A method has been developed for the photometric determination of vanadium in residual fuel oils and was published as information in 1955. Improved methods for determining small amounts of tetraethyllead in the reference fuels used in engine testing are being developed. One such method, D 1368, was published as tentative in 1955.

The improvement of existing methods and the development of alternate methods for determining tetraethyllead in gasoline continues to be a subject of interest. The Polarographic Method (D 1269) was revised in 1955 to make the method encompass the use of push-button polarographs. The Institute of Petroleum is interested in this work. Short methods for determining tetraethyllead, such as versene titration and flame photometric procedures, are being reviewed. If one of these shows considerable promise, either Method D 526 or D 1269 may be replaced.

The method for sulfated residue from new lubricating oils (D 874) was revised to indicate the additive metals in new lubricating oils and the behavior of their sulfates on ignition at 775 C.

A survey of railroad laboratories resulted in the preparation of a procedure outlining current practices in sampling diesel-locomotive crankcase oils.[1] Five study groups are reviewing different methods for spectrographic analysis of used diesel lubricating oils in order to develop methods to determine wear metals in the oils. Plans are being made to publish this year the methods being studied by the groups. This publication should be available at the joint Research Division III-Technical Committee B, Symposium on Trends in Lubricating Oils which will be held in September, 1956 in Los Angeles.

Research Division IV on Hydrocarbon Analysis *W. E. Scovill, chairman*

The work program of this division has developed around the objective of providing standard methods for determining separate hydrocarbons and hydrocarbon types in petroleum and its fractions. Several analytical tools are involved in the preparation of the methods. These include: determination of olefins and aromatics by acid treating and bromine number; hydrocarbon types by chromatography; determination of hydrocarbon types and purity by refractive index, freezing point, and spectroscopic methods; determination of aniline point, and a study of methods to correlate physical data with other properties of hydrocarbons.

Correlation of results obtained with Methods for Olefinic plus Aromatic Hydrocarbons (D 1019), and for Hydrocarbon Types in Liquid Petroleum Products (D 1319), is being reviewed. An extensive review and cooperative test program has been made on ASTM bromine number methods D 1158 and D 1159. The programs have developed some significant information that should result in the recommendation of revisions of the methods and their extension to cover other types of samples. The fluorescent indicator adsorption method for hydrocarbon types (D 1319) has been cooperatively tested with the result that changes were made to improve accuracy.

Work on density and refractive index includes a study of methods at elevated temperatures. Procedures for calculating olefins and gasoline from bromine number, specific dispersion, and acid treating data are being reviewed. Density Method D 941 was enlarged to include a procedure for calculating specific gravity from density.

Freezing point methods D 1015 and D 1016 were revised by moving the description of the procedures and apparatus for drying into D 1015. Both methods were adopted as standard. A proposed method of test for benzene, toluene, ethylbenzene, and individual xylenes by infrared spectrophotometry was published as information. Studies are continuing on a method of test for hydrocarbon types in gasolines by mass spectrophotometry.

A cooperative test program was conducted to establish a firm specification for the aniline reagent used in the Method for Aniline Point and Mixed Aniline Point of Petroleum Products and Hydrocarbon Solvents (D 611).

During the past year, the work on the analysis of reference fuels has been concerned with the identification of hydrocarbon impurities in *iso*octane. Two samples, a certified reference fuel and an impure fuel from the same manufacturing process, were analyzed by combined distillation and infrared spectroscopic techniques and by vapor-liquid partition chromatography. No harmful concentrations of impurity were detected in either of the samples.

The development of methods for the analysis of reference fuel *n*-heptane has been deferred, as engine fuel rating methods are less precise for low octane number fuels.

Future programs in the division include preparation of a manual on hydrocarbon analysis, work on the identification of impurities in commercial *iso*octane, and the correlation of molecular weight of hydrocarbons with other data.

[1] ASTM BULLETIN, September, 1955, p. 24.

THE SOCIETY APPOINTS:

M. P. DAVIS reappointed to ASA Safety Standards Board

M. N. CLAIR reappointed to ASA Construction Standards Board

P. O. NICODEMUS to ASA Sectional Committee C59 on Electrical Insulating Materials

R. J. ALLEN to ASA Sectional Committee B73 on Centrifugal Pumps for Chemical Industry Use

D. C. BRAND to ASA Chemical Industry Advisory Board, succeeding R. C. Thumser

C. L. MATZ, R. J. HADER, R. A. BRADLEY, and GERALD LIEBERMAN to Committee E-11 on Quality Control

D. L. COLWELL to American Foundrymen's Society Light Metals Division, succeeding Walter Bonsack

R. J. WIRSHING to Administrative Committee on Papers and Publications, succeeding M. Van Loo

G. R. GOHN as Society's representative at 100th Anniversary of Brooklyn Polytechnic Institute

ALEXANDER GOBUS to ASA Sectional Committee on Shockproof Cable Terminals and Receptacles

J. B. RATHER, JR., to Administrative Committee on Standards, replacing A. E. Miller, resigned.

The Quality of Radiographic Inspection

By D. T. O'Connor and E. L. Criscuolo

An analysis of present radiographic requirements on a relative and on an absolute scale, from the point of view of radiographic coverage. Proposed is a simple revision of existing penetrameter design and use which will permit three basic radiographic quality levels to be gaged simply and directly.

As every inspector knows, it is quite easy to make poor radiographs. The large number of technique variables, the wide variety of problems facing the average radiographer and the natural desire for high production, all contribute to the difficulty of maintaining a high standard of radiographic quality. The high standard that actually is maintained is a tribute to the very considerable personal skill of practicing radiographers.

But a procuring agency is loath to rely on such an indeterminate quantity. A variety of methods have, therefore, been devised to provide assurance of a reasonable quality level. Generally, there are two approaches to this goal; one approach attempts to standardize X-ray technique, the other to provide a quality indicator on the radiograph itself.

The former is best exemplified by the system established by the Aeronautical Inspection Directorate, Harefield House, Middlesex; in this system every Royal Air Force casting is classified by A.I.D. Techniques are officially established and identified with specific castings; they must be rigidly followed by the radiographer.

The latter approach places some degree of reliance on the effectiveness of the penetrameter to gage radiographic quality. This system, with many variants, is used widely, particularly in the United States.

In addition to these more or less direct administrative methods of controlling image quality, there are a few supplementary ones. Both X-ray laboratories[1,2] and operators[2] may be required to meet minimum qualification standards. Then there are general procedural specifications[3,4,5] that define areas in which technique selection is permitted. Finally, there are specific product specifications[6] calling for comparison films whose quality affects the product quality and which are therefore to some extent quality controlling.

Some of the technical societies have been active in exploring the radiographic quality problem and in some instances have provided basic operational procedures and requirements. Of first interest among these are The American Society of Mechanical Engineers and the American Society for Testing Materials. In the early 30's the ASME adopted the Boiler Code, including substantially the same radiographic procedural and quality code in use today.[7] ASTM in its Committee E-7 on Nondestructive Testing has been quite active recently in this area. Subcommittee I of Committee E-7 has prepared a document entitled "Recommended Practice for Radiographic Testing," which in the words of its editor is a "concise guide to satisfactory radiographic practice." During its preparation some subcommittee members felt that there should be a more direct method of controlling radiographic quality and urged the consideration of a radiographic specification not unlike those of the military. Subsequently, Subcommittee V was set up to attempt to develop such a quality specification.

Present Requirements

The services have been confronted by a whole new set of inspection problems stemming from the engineering requirements of materials for nuclear applications. A higher quality standard than the normal is required for this work. On the other hand certain classes of work in other fields have less stringent quality requirements than the normal. It is therefore being proposed that distinctions be made in the quality requirements for different classes of radiographic work. This concept is not new; it played an important part in the early discussions that preceded the adoption of the ASME Boiler Code. The Bureau of Ships of the U. S. Navy Department and Subcommittee V of ASTM Committee E-7 are currently engaged in the preparation of new radiographic inspection specifications. The multiple quality level idea is being considered for use in these. It is the purpose of this paper to examine this concept.

In the first place a very large variety of items are intended to be covered by these specifications. The radiographic inspection is expected to be conducted by many persons under a great variety

NOTE.—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the author. Address all communications to ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa.

[1] MIL-X-6141A(ASG), July 15, 1954, X-ray Laboratories, Procedure for the Certification of.

[2] MIL-R-11470, Sept. 24, 1951, Radiographic Inspection, Qualification of Equipment, Operators and Procedures.

[3] MIL-R-11471(ORD), Sept. 24, 1951, Radiographic Inspection of Metals.

[4] General Specifications for Inspection of Material, Appendix II, Metals, Part F, Radiography, BuShips Navy Report, Mar. 1, 1952.

[5] MIL-I-6865A(ASG), Mar. 26, 1953, Inspection, Radiographic.

[6] MIL-C-6021A(ASG), Aug. 18, 1952, Castings, Classification and Inspection of (for Aeronautical Application).

[7] ASME Boiler Code (Construction), Section VIII, Unfired Pressure Vessels, U-68 C1950 ASME.

Donald T. O'Connor, director of industrial X-ray engineering, Machlett Laboratories, Springdale, Conn., and Vice-Chairman of ASTM Committee E-7 on Nondestructive Testing, is the author of numerous papers on applied X-rays. He was the first recipient of the Society for Nondestructive Testing's Coolidge Award for original work in the field of X-ray engineering.

EDWARD L. CRISCUOLO, chief of the Radiology Section, Naval Ordnance Laboratory, Silver Spring, Md., joined the radiographic group in 1949. Some of his efforts have been directed towards developing ultra-high-speed flash X-ray equipment, a fine-focus flash X-ray tube, and a filmless recording method

TABLE I.—PENETRAMETER TYPE COMPARISONS.

	Sphere Diam = T	Plaque Thickness = T	Wire Diam = T	Area Depth = T
Relative difficulty of seeing (All T's equal)	4	3	2	1

of circumstances. It is therefore believed to be impractical to specify techniques by item. The second approach to a uniform radiographic quality level is therefore taken, that is, reliance on some sort of quality indicator, a device that should enable the inspector to assess easily the acceptability of individual radiographs.

In special cases where large numbers of identical items are inspected, this indicator may take the form of a test specimen containing actual or simulated defects of borderline acceptability. The periodic reexamination of the test specimen and the finding of these "flaws" reassures the inspector that the radiographs are of an adequate quality level.

More often the quality indicator is the penetrameter, a small piece of material of the same composition as the specimen and of a thickness equal to some predetermined percentage of the specimen thickness.

On Penetrameters

In the past, a good deal of attention has been given to the problem of the design and use of penetrameters. There has even been some discussion of the advisability of using the word "penetrameter" itself for the purpose implied earlier, that is, as a quality gage, but whatever they may be called, penetrameters are quite generally in use today. They embrace a wide variety of shapes and sizes. They have been designed in the form of solid spheres, hollow spheres, solid cylinders or wires, hollow cylinders or drilled holes, solid washers and hollow washers or crack-like cavities. The thought (1)[8] behind these designs is varied from the one expressed, namely a device for the assessment of radiographic quality, to the simple idea of defect simulator. The latter concept arises again and again because of the obvious relationship between radiographic quality and the ability of the radiograph to reveal specimen defects. It is beginning to be obvious to most users of these devices that it is impractical to simulate defects and that their ends are gained as well by striving for quality assurance there is no way in which a clever gadget, artfully placed, can conceivably overcome the classic failure of penetrating radiation to discover laminar faults.

Some of the discussion has been in the form of criticism of the conventional plaque-type penetrameter generally in use today in the United States, Canada, and Great Britain. The penetrameter is generally constructed of the same material as the specimen to be examined and is $\frac{1}{50}$ of the specimen thickness. It usually contains drilled holes whose diameter is a function of the thickness. Some have felt that this device is ineffective in revealing contrast changes (2), others in pointing out its limitations for larger thicknesses inferred that it fails in discriminating between changes in definition (3). All agree that some changes either in design or use are desirable, and this question is in active consideration by both the International Institute of Welding (4) and the ASTM.

The literature (1, 5, 6, 7, 8) reveals examples of excellent and informative studies on the feasibility and the general usefulness of the different types of penetrameters already referred to. In a general way these may be summarized (see Table I) as follows:

1. There is no significant difference in the difficulty of seeing the void type as opposed to the solid type artifact.
2. Between the basic types of flat, cylindrical, and spherical artifacts the degree of difficulty may be expressed in the ratio of 1:2:4. Two quite comprehensive and independent investigations (5,6) have led to this result. The basic experiments were performed in the medium of fluoroscopy, but the principle is generally applicable to film presentation as shown by a partial corroboration (7) by a third investigator.
3. When the two types of penetrameters are compared and appear equally visible through the same specimen thickness, the ratio of the sensitivity indicated by the wire type compared to that indicated by the plaque type is 1:1.5. (1, 7). That is, for equal perceptibility, the thickness, T, of the wire will be less than the thickness, T, of the standard penetrameter.
4. It has been reasonably well demonstrated that the normally attainable penetrameter sensitivities using conventional penetrameters fall in the range of 0.5 to 1 per cent for all practical energy ranges. This implies that artifact sizes based on thickness should be a reasonable premise for penetrameter design; it is a basic idea borrowed from physical testing measurements on engineering materials. In other words conventional penetrameter thickness should be a proper way to describe a sensitivity requirement since it makes the same demand at all energy ranges from the point of view of radiographic performance.

Table I affords a general view of the behavior of the basic penetrameter types. By the plaque type is meant the conventional United States penetrameter where the diameter of the smallest hole to be seen is twice the penetrameter or plaque thickness. Penetrameters could be designed as plaques with slits, wedge-shaped cuts, diamond-shaped holes or in an almost unlimited variety. But their perceptibility would vary systematically and they could be inserted in an enlarged Table I. The choice is very wide.

Minimum Size of Observable Defects

One of the limitations not often recognized in radiography is the difficulty of obtaining a quality of inspection in the

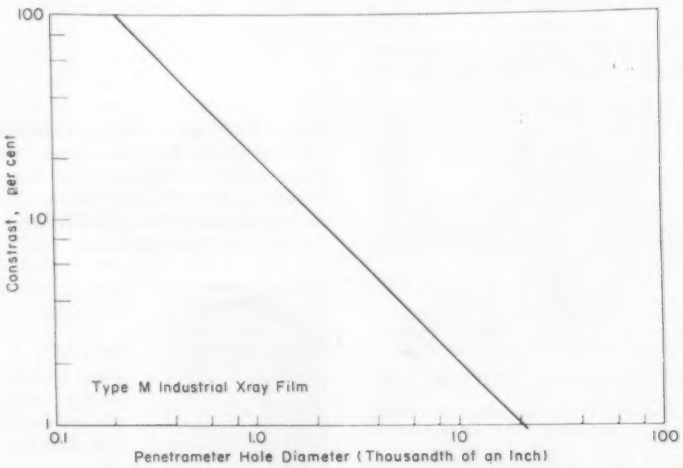

Fig. 1.—Relationship Between Contrast and Definition for Minimum Perceptibility.

[8] The boldface numbers in parentheses refer to the list of references appended to this paper.

thinner sections comparable to that obtained in the thicker sections. This difficulty is associated with the fact that the drilled hole in the penetrameter is never smaller than 0.030 in. and always twice as wide as the penetrameter is thick. As has already been indicated, large area cavities are more readily seen than small area cavities of equal thickness; for example, larger penetrameter holes are more readily seen than the smaller holes on the same plaque. This characteristic has been noted by others, particularly Burger (9) who has attempted to define it quantitatively but who does not attempt to explain it.

Following Rose's (10) premise that the performance of the eye is limited by the statistical fluctuation of the luminous flux, Sturm and Morgan (11) applied this type of analysis to the imaging problem. Their analysis leads directly to a limiting relationship between contrast and perceptible image dimension, expressed generally as:

$$d = \frac{K}{C} \quad \ldots\ldots\ldots\ldots (1)$$

where:

d = minimum perceptible defect,
K = constant, and
C = radiographic contrast
$= (I_2/I_1) - 1 = \Delta I/I, (I_2 > I_1)$

(In the case of radiographic quality, the factor K includes variables in technique affecting sharpness as well as film-gradient; in order to explore the relationship between d and C, K is held invariant.) The self-same expression results from a consideration of the limitations imposed on image quality by the unsharpness of a given imaging surface (12). The general validity of this expression may be tested directly for a given emulsion by noting the contrast or density difference between a penetrameter image and the adjacent background and the changing penetrameter hole visibility as contrast is varied. Contrast may be varied simply by changing exposure, kilovoltages, or both. Figure 1 illustrates this reciprocal relationship between contrast and resolving power for type M film. Density differences were expressed in per cent contrast[9] and plotted against minimum perceptible hole size. This performance curve extrapolated to 100 per cent contrast giving a resolving power[10] rating of about 100 lines per millimeter for type M film represents a reasonable approximation of the known performance of this film. Changes in radiographic technique such as changing film types would produce a family of parallel lines.

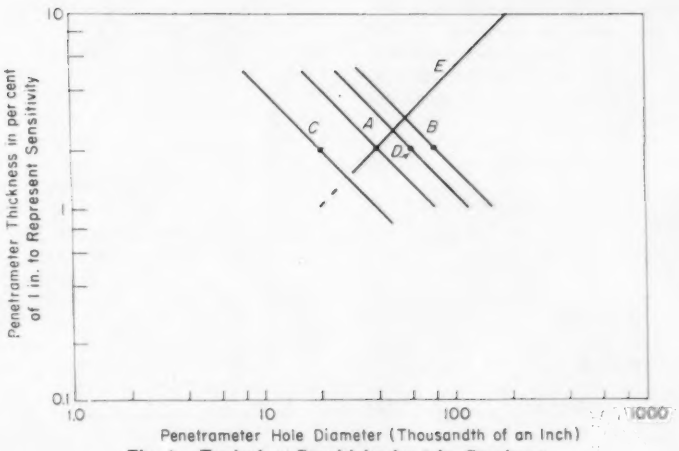

Fig. 2.—Equivalent Sensitivity for 1-in. Specimen.

A, *B*, *C*, *D* represent minimum visibility points. Parallel lines through them represent levels of radiographic quality. *E* represents the definition of the penetrameter for 1-in. plate.

Present Radiographic Requirements

At the present time the great bulk of the radiographic work done in the United States conforms to the requirements of the Military Specifications or the Boiler Code. These requirements are summarized in Table II. Although technique requirements are not completely absent they are definitely subordinate to penetrameter evaluation. It is interesting to note that all branches of the Defense Department have attained close agreement on penetrameter design, although there were a number of variations only a few years ago. All have gone to smaller minimum hole diameter.

Why three holes in the penetrameter? Presumably because of the original concept of multiple quality levels. The requirement is universal that all holes be visible. It is obviously more difficult to reveal the smallest hole; if it is visible then the larger holes cannot fail to be visible.

Sometimes only one or two holes are visible. The question may arise as to the sensitivity represented by this condition. This situation is graphically illustrated in Fig. 2 which represents an arbitrary X-ray technique on a 1-in. thick specimen. The abcissa is the minimum perceptible penetrameter hole diameter, the ordinate is sensitivity. The film response as expressed by $d = K/C$ for minimum perceptibility has already been mentioned. To use this type of presentation it is necessary to show that of the variables concerned, sensitivity and contrast are linearly related. This is simply done by referring to the differential form of the basic absorption law:

$$C = \frac{\Delta I}{I} = \mu \Delta X \quad \ldots\ldots\ldots (2)$$
$$= \mu X \frac{\Delta X}{X}$$
$$= \mu X S$$

where:

C = contrast,[11]
I = intensity,
X = thickness,
μ = linear absorption, coefficient, and
S = radiographic sensitivity

For a fixed technique, μX is a constant.

Referring to Fig. 2, assume it is desired to see point A, that is the (0.040-in.) hole at 2 per cent contrast sensitivity, but the technique used actually reveals only the third hole (0.080 in.), point B. If it revealed a 1T hole (0.020 in.), point C would represent it; if the second hole (0.060 in.), D would represent it. Lines having a negative slope of one drawn through these points represent various radiographic qualities as determined by

TABLE II.—RADIOGRAPHIC QUALITY REQUIREMENTS.

Type of Requirements	Military Specifications	Boiler Code
Visibility of penetrameters..	Must see holes	Must see holes
Thickness of penetrameters, per cent.....	2 Except Mg which is 3%	2
Minimum thickness, in.....	0.005	0.005 by custom and practice
Minimum hole diameter, in.	0.030	1/16 (except for gamma ray 3/32 in.)

[9] 100 per cent contrast means a density difference of 0.3; see Eq 1.

[10] $\frac{40}{2X}$ dimension perceptible hole diameter (in 0.001 in.-lb) = lines per mm.

[11] Strickly speaking this presentation is true only for subject contrast. However, for a fixed technique it is clear that subject and radiographic contrast differ only by a factor of proportionality, the film gradient.

the minimum penetrameter hole visibility through a 1-in. specimen.

By definition the penetrameter hole which must be seen is the $2T$ diameter hole where T is the 2 per cent penetrameter thickness, that is:

$$d = \Delta X N$$

where N is an integer equal to 2 for the Codes, $T = \Delta X$

but

$$d = \frac{K}{C}$$

where $C = \mu \Delta X$

$$\Delta X^2 = \frac{K}{N\mu} \quad \ldots\ldots\ldots\ldots (3)$$

or

$$\frac{\Delta X}{X} = S = \left(\sqrt{\frac{K}{\mu}}\,\frac{1}{X}\right)\frac{1}{\sqrt{N}} \quad \ldots\ldots (4)$$

The expression in brackets for this situation is a constant. Therefore, the contrast sensitivity for a given specimen thickness, must vary inversely with the square root of N. That is to say, when the holes are large the contrast sensitivity needed to see them is small and *vice versa*.

The expression $\Delta X/X = S$ is a definition of contrast sensitivity. Since sensitivity is more usually determined and discussed in terms of penetrameter sensitivity, the latter quantity should be defined. Fortunately this is now convenient. It should be the diameter of the minimum discernible hole, (hole depth = ΔX, hole diam = $N\Delta X$) divided by the specimen thickness, and from Eqs 3 and 4, directly proportional to $\sqrt{N}$:

$$S_{\text{(penetrameter)}} = \frac{d}{X} = \left(\sqrt{\frac{K}{\mu}} \cdot \frac{1}{X}\right)\sqrt{N} \quad \ldots (5)$$

where d is the diameter of the cylindrical penetrameter hole of diameter equal to $N\Delta X$ and depth equal to ΔX.

That is to say, as the hole size in a plaque type penetrameter is decreased, the numerical value of penetrameter sensitivity it represents becomes smaller. If, for the specified problem a 2 per cent penetrameter with a given technique provides a radiographic image of only one hole instead of all three, the actual or equivalent penetrameter sensitivity must be:

$$S_2 = S_1\sqrt{\frac{N_2}{N_1}}$$

or

$$S_2 = \frac{2\sqrt{4}}{\sqrt{2}} = 2.8$$

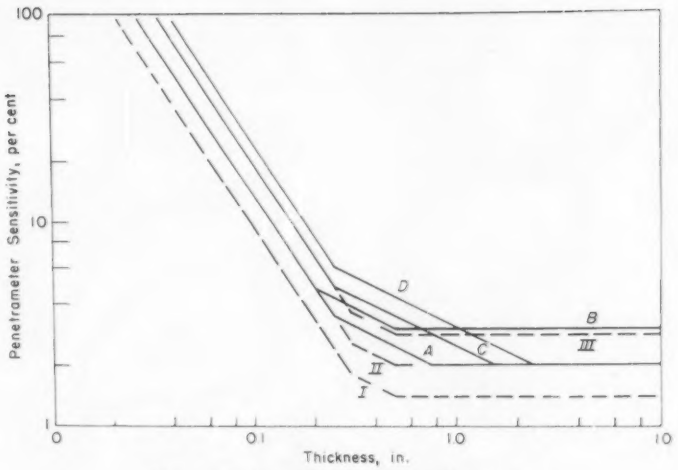

Fig. 3.—Radiographic Quality Requirements.
Curve *A*—existing military specifications
Curve *B*—magnesium
Curve *C*—boiler code as practiced, X-ray
Curve *D*—boiler code as practiced, gamma ray
Curves I, II, III, proposed quality levels.

The term "equivalent sensitivity" is meant to imply that if only one hole in a code penetrameter is seen the same radiographic technique would resolve all three holes in a penetrameter whose thickness was 2.8 per cent of the specimen thickness.

This situation is shown graphically in Fig. 2, curve *E*, which is the definition of penetrameter sensitivity for the 1-in. plate, see Table III.

TABLE III.—TABULAR DEFINITION OF PENETRAMETER SENSITIVITY FOR 1-IN. PLATE.

Penetrameter Sensitivity, per cent	Minimum Perceptible Hole Diam, in.
1.....	0.020
2.....	0.040
3.....	0.060
4.....	0.080
5.....	0.100
6.....	0.120
7.....	0.140
8.....	0.160
9.....	0.180
10.....	0.200

From the expressions given or from Fig. 2 it is now possible to give the actual penetrameter sensitivity attained as determined by hole visibility. These are listed in Table IV.

TABLE IV.—STANDARD PENETRAMETER SENSITIVITIES AS DETERMINED FROM MINIMUM PERCEPTIBLE HOLE DIAMETER.

Minimum Perceptible Hole Diam (T = 1/50 Specimen Thickness)	Equivalent Sensitivity, per cent
$1T$.....	1.4
$2T$.....	2.0
$3T$.....	2.4
$4T$.....	2.8

It is now possible to present graphically the present radiographic quality requirements and to see how well they give assurance of adequacy. Figure 3 includes both the generalized Military requirements and the provisions of the ASME Boiler Code. If the goal of such codes is to insure a given arbitrary quality (say 2 per cent sensitivity) throughout the range of inspection thickness, then it is quite clear that much is to be desired. The quality of inspection under Military specifications is uniformly high from $\frac{3}{4}$-in. thicknesses and up; relatively poorer quality is accepted down to $\frac{1}{4}$ in. because the minimum hole diameter required to be seen is 0.030 in. Below $\frac{1}{4}$ in. the required quality drops sharply, because 0.005 in. is the smallest thickness of penetrameter required to be used.

The situation is even worse with respect to the Boiler Code because the minimum hole diameters are $\frac{1}{16}$ and $\frac{3}{32}$ in., respectively, for X-ray and gamma ray work. Although the code does not specify a minimum penetrameter thickness, in practice no penetrameters thinner than 0.005 in. are in general use. The net result is that in the range of 0.1 in. to 2 in. the practical working sensitivity may range from 2 per cent to 24 per cent and still must be considered acceptable by the inspector.

It is in this context that the nuclear quality inspection demands must be viewed.

Provisions of a Three-Quality Level Specification

The proposed specification retains the basic concept underlying present U. S.

practice, namely, that a radiograph must be judged directly on its own basis and not indirectly through administrative technique control. The basis of judgment remains the same, namely, the perceptibility of the penetrameter, whose thickness is generally 2 per cent of the specimen thickness and which is constructed of essentially the same material as the specimen.

The new penetrameter design retains the three holes and uses all three of them to assign a minimum quality level to a radiograph. The hole diameters are $1T$, $2T$, and $4T$, respectively, where T is the penetrameter thickness (or $\Delta X/X =$ 2 per cent). Minimum quality levels may be assigned on the basis of the perceptibility of one, two, or three holes. These radiographic quality levels are associated with the previously specified inspection quality requirements, according to Table V. The adjective descriptions of the classes of work are most general and are intended to illumine rather than restrict. Quite clearly, it is the prerogative of the procuring agency to specify the quality level of the inspection desired.

TABLE V.—BASIC REQUIREMENTS OF THE PROPOSED SPECIFICATION.

Classes of Work	Radiographic Quality	Minimum Perceptible, Penetrameter Hole	Equivalent Sensitivity, per cent
Nuclear....	I	1T	1.4
Pressure...	II	2T	2.0
Structural..	III	4T	2.8

It was originally intended to place no restriction on minimum penetrameter thickness and a very low limit on minimum hole size in order to get better quality coverage in thin sections. This objective could not be met as is indicated below. Therefore the minimum hole diameters are 0.010, 0.020, 0.040 in., respectively, for classes I, II, and III; the minimum penetrameter thickness is 0.006 in.

The reason for placing these limitations on penetrameter design is not the difficulty of making them or the inability of the radiographic process to record small contrast changes in thin sections. Quite the contrary. Surprisingly enough the limiting factor is the resolution of available X-ray films. Figure 4 shows the situation at a glance; the straight solid lines show the new quality requirements as a function of equivalent sensitivity and thickness. The straight dashed lines show the limiting practical resolution of four commonly used films.[12] The departure from the horizontal of the class I curve is caused by the limiting hole diameter of 0.010 in. The second abrupt change in slope (going to the left) is caused by the limiting thickness of the penetrameter. Only by imposing such arbitrary restrictions is it possible to keep the radiographic requirements from exceeding the capabilities of the available X-ray films. On the other hand the contrast sensitivity of the X-ray process is indicated by the series of limiting sensitivity curves associated with common operating voltages—the thickness scale being read for steel.

Referring back to Fig. 3 it will be noted that class II quality closely parallels the existing military requirements and that class III below 1 in. is closely matched by the Boiler Code; for greater thickness it is less stringent. Class I, on the other hand, represents a superior quality level throughout; the magnitude of this greater demand in a numerical value is about the $\sqrt{2}$.

The situation for high-quality inspection, say of weldments from $\frac{1}{32}$ in. to $\frac{1}{4}$ in. still leaves much to be desired. Should improved materials become available, however, it would be easy to revise the present penetrameter limitations without changing the basic design.

Basic Considerations Underlying a New Specification

These considerations might be listed briefly:

1. Provide for a higher quality radiographic inspection level for nuclear work.
2. Retain as much of the existing system as possible.
3. Provide for simple working practice.

The first two considerations have already received some attention. The last concerns itself with the working details, such as source and film selection, penetrameter placement, technique and the like.

The main premise of the new specification, as of the old, is that quality determination shall be by penetrameter. Thus no restriction is placed on technique selection. Nevertheless, sometime, someone must make this decision in any given case. Figure 4 illustrates the relative ability of the four common film types to meet this quality requirement. The most serious restriction, of course, occurs in the thin sections, as mentioned; however it should not be overlooked even though not graphically illustrated here that in the thicker sections a definite quality improvement in a given technique may be effected by changing to a slower film. The same idea applies to source selection, although a satisfactory image may be obtained with a given energy source, an improvement may be possible in a given situation.

The more important concept with respect to energy selection is that the new specification does not distinguish between X-ray and gamma-ray techniques. If the technique will produce the desired result as shown by the penetrameter image, it is considered adequate. For example, judging by the results of one paper (**13**) iridium 192 would not normally be selected for class I aluminum work, although class II might be done at thicknesses above $1\frac{3}{8}$ in. If, however, another radiographer, using an improved technique could meet the radiographic quality requirement, the radiograph would certainly be accepted. In other words, no penalties—or rewards—are attached to methods.

Since the orientation of defects in a given specimen is usually unknown, it is

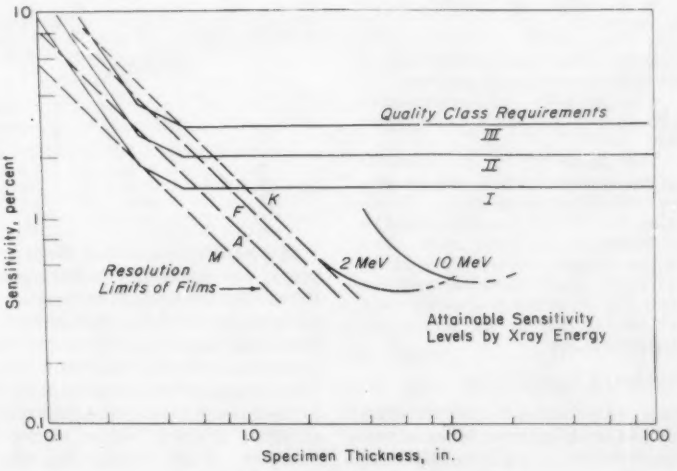

Fig. 4.—Radiographic Quality Limits.

[12] The dashed lines were derived from Figs. 5, 6, and a third curve not published.

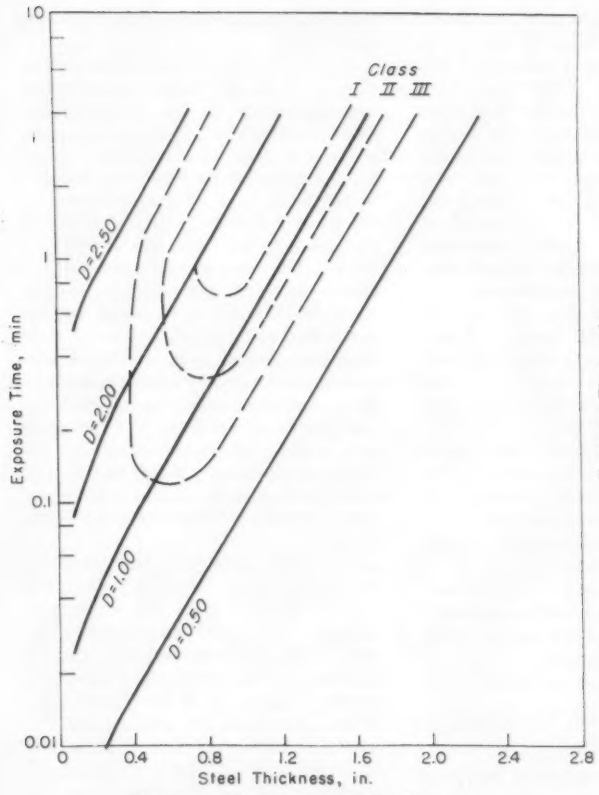

Fig. 5.—Technique and Quality Curves.
Steel, 250 KVCP, type-F film, lead screens, 10 ma, 6 ft, proposed penetrameter

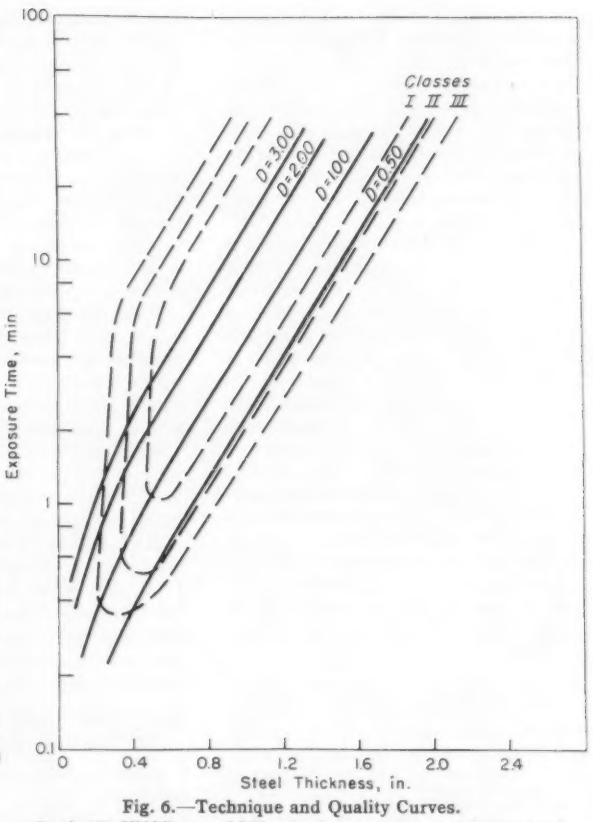

Fig. 6.—Technique and Quality Curves.
Steel, 250 KVCP, type-M film, lead screens, 10 ma, 6 ft, proposed penetrameters.

not usually possible to position the specimen perfectly. Generally the orientation is random. Since the hole in the penetrameter is a limiting measure of perceptibility, it obviously should not be randomly located; on the contrary, it should be placed in the most advantageous position in order to give assurance that, if it is not seen it is technique that is at fault, not geometry. In other words:

1. Penetrameter hole perceptibility is the measure of radiographic quality;
2. The geometry of penetrameter placement does not affect radiographic quality;
3. The geometry of penetrameter placement should therefore not be permitted to limit hole perceptibility. It follows then that the penetrameter should be placed normal to the X-ray beam. The useful radiographic coverage would be limited to the areas where the radiation intensity fall off is within approximately 50 per cent of that at the satisfactory penetrameter image.

Application of Specification

The way in which such a specification would affect radiography carried out in conformance with it is graphically illustrated in Figs. 5 and 6. These are combined Technique and Quality Curves made at 250 kv (focal spot = 5 mm.) on steel using the new penetrameter design. The relative difficulty of achieving the different quality levels may be estimated from the range of thickness properly examined for a given exposure. See Table VI. ("Ideal" means no limiting thickness or hole diameter.)

TABLE VI.—RANGE OF STEEL THICKNESS COVERED AT 250 KV BY CLASS, (TAKEN FROM FIG. 5, 1 MIN EXPOSURE).

Class	Thickness, in.	Thickness Range, in.
I.....	0.8 to 1.1	0.3
II.....	0.6 to 1.3	0.7
III.....	0.45 to 1.5	1.05

It is readily seen that as might be expected the higher the quality required the smaller the range of coverage. The variation in the loop area between different film types shows how this range coverage is affected by film selection. The position of the loop apex in relation to thickness is a measure of the relative ability of a given film to resolve fine structure. These quality curves are generated in exactly the same way as the sensitivity loops discussed in the literature (**14, 15, 16**). Data of this type may be prepared for any variety of techniques to permit the radiographer to prejudge a proposed technique in a specific case to determine its fitness for meeting the known quality requirements.

Conclusion

The administrative question of radiographic quality control has been examined from both a general and a practical point of view. The question of subject artifact perceptibility in radiographs has been discussed and reference made to basic studies of this question. Present radiographic requirements have been analyzed on a relative and on an absolute scale, from the point of view of radiographic coverage. A simple revision of existing penetrameter design and use has been proposed which will permit three basic radiographic quality levels to be gaged simply and directly. The top quality level, class I, is well within the capacity of the radiographic process; class II closely parallels existing Military requirements, and class III represents the loosest requirements. The establishment of a new higher

quality level is prompted by the more stringent requirements inherent in material consideration for nuclear applications. The lower quality level represents a quality standard that is practical and economical for many existing situations and practices.

Acknowledgement:

It is a pleasure to acknowledge the help and guidance of Robert Lyons, James Bly, Carleton Hastings, Herman Seemann, E. A. Burrill, Daniel Polansky, Walter Hampe, A. L. Pace, George Corney, and Royal Tobey.

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A Suggested Method of Testing Detergents for On-Location Rug Cleaning

By J. W. Rice

Editor's Note.—Performance testing is an area in which there is a vast amount of experience in ASTM. The crux of this type of test is in the correlation of test results with service conditions. For most engineering materials, service conditions may be defined objectively though not necessarily explicitly and development of tests which correlate with performance in actual service is an engineering job. In the area of consumer goods, including textiles and detergents, subjective factors enter to complicate the picture. Although instruments can be used to make unbiased objective measurements, there remain the human factors not measured by the instruments but which need to be taken into account. This aspect of the Society's work is under the cognizance of the Administrative Committee on Ultimate Consumer Goods which in 1951 sponsored a Symposium on Measurement of Consumer Wants at which the area of objective measurement of subjective factors was explored.

In this paper the author reveals some of the problems of performance testing which continue to plague those working in this area.

DURING the past two years the Tufted Cotton Manufacturers Assn. and the National Institute of Rug Cleaning have cooperated in a project to develop methods for in-place cleaning of tufted cotton carpets. As a part of this project an investigation was carried out for evaluating detergents so that the most effective ones could be selected. Although the program was carried out with particular reference to cotton carpets, it is reasonable to assume that the same methods would be applicable to cleaning carpets composed of other fibers including wool and the synthetics.

The final report on this project entitled "How to Clean Tufted Cotton Carpet on-Location" is available from the National Institute of Rug Cleaning.

In recognition of the need for a uniform and standard testing method for all rug cleaning agents, the principal findings of the investigation are reported herein as a step in the direction of establishing a standard method. The method presented should provide a basis for further work toward development of a standard. In the course of further development, a number of questions which should be resolved include the following:

(*a*) Do reflectometer readings correlate closely enough with customer acceptance

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The Author . . .

J. W. RICE, director of research, National Institute of Rug Cleaning, for the past 6 years, spent 30 years as an officer in the Army Chemical Corps in the development of gas-proof materials and clothing.

Fig. 1.—Reflectometer with Automatically Adjusting Potentiometer.

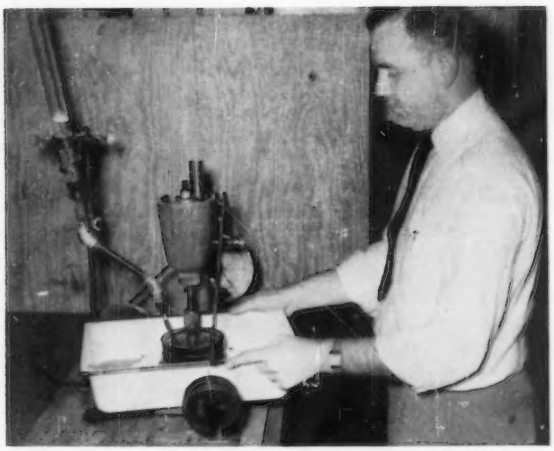

Fig. 2.—Improved Laboratory Rotary Brush Scrubber.

to warrant dependence on a reflectometer method of evaluation?

(*b*) Should an exact laboratory model of a cleaning machine be designed and, if so, what are its specifications?

(*c*) If a reflectometer or similar instrument for obtaining numerical data be adopted, what is the performance level that will meet with customer acceptance?

(*d*) If reflection data be employed for judging the performance, how specifically should these data be evaluated?

(*e*) Should performance be based on cleaning naturally soiled test samples, or should artificial soil and mechanical application methods be developed?

Briefly, the method consists of comparing the reflectance recovery of a number of swatches cleaned to an arbitrarily chosen performance standard using a small laboratory model of a conventional type professional cleaning machine.

Equipment

The following special equipment was used for the test work:

A modern reflectometer with a movable head connected by electric cables to an automatically adjusted potentiometer unit was used for obtaining the numerical comparative data (Fig. 1). With this, readings could be made over considerable areas, especially since the aperture of the instrument was covered by a clear planar glass plate and could be set face down on the local area to be measured. This enabled the operator to measure reflectance of each spot under the same pressure. The scale of the instrument which is shown in Fig. 1 was calibrated in reflectance units from 0 to 100.

For soiling test swatches, a plywood board of suitable size was made. Swatches were fastened to the board with staples.

Cleaning on a laboratory scale was accomplished by means of a belt-driven rotary brush, improvised from a drill press arbor, a small electric motor, and a 5-in. fiber bristled disk brush from a floor-polishing machine as illustrated in Fig. 2. This brush was fitted with a channeled plate on top, and holes were drilled through to permit flow of the detergent to the rug sample. A reservoir fitted with a petcock and rubber delivery tube to the brush channel was mounted near the apparatus. A weight on the arm of the drill press completed the apparatus. This brush operated at the average linear bristle speed of 450 to 500 ft per min, comparable to that of most commercial cleaning machines. The required brush pressure was calculated to be about 1 psi and represents the average weight of commercial machines on the same areas of brush contact.

A small board to which the test swatches could be attached while being cleaned was also provided. To prevent splashing the detergent, this board was set in a rectangular pan.

Preparation of Test Swatches

New tufted cotton carpeting was washed by two sudsings in a 0.25 per cent solution of 40 per cent active anionic detergent at 120 to 130 F, rinsed four times at 120 to 90 F and dried by tumbling at 140 to 150 F.

Swatches (5 by 5 in.) were cut and the reflectance of each read through two filters, blue and green, in four directions; the averages were calculated and recorded as the original reflectance.

The swatches were tacked to a plywood board and placed in a well-traveled passageway for soiling by natural wear. The board with samples attached as shown in Fig. 3 was changed in direction and position and vacuumed daily.

Spot reflectometer readings were also made from time to time and when the readings had dropped to between 50 and 60 on the scale, or about 40 per cent of the maximum probable drop (assumed to be 60 points), the individual swatches were removed and replaced by clean ones. (Incidentally, the original samples averaged about 80.) The reflectance of these soiled swatches was then read in the same manner as at first and the averages recorded.

Twelve of the samples with very nearly the same mean green-filter reflectance were then selected for each detergent under test. The following cleaning routine was developed:

(*a*) Samples were attached to the holder.
(*b*) The brush was rinsed and wet throughout with the detergent solution.
(*c*) 50 ml of the detergent solution was placed in the reservoir.
(*d*) The machine was started and the pan containing the holder and sample placed beneath the brush.
(*e*) The rotating brush was then lowered onto the sample and at the same time the detergent petcock opened.
(*f*) The sample was passed back and forth under the rotating brush for 18 sec, after which the arm was raised and the swatch holder removed.
(*g*) Excess suds were vacuumed off and the pile fluffed by an air jet, after which the sample swatch was lifted from the holder and laid out for drying at room temperatures.
(*h*) Upon drying, swatches were rolled through a wringer set at an arbitrary standard pressure setting.
(*i*) Reflectance of the cleaned samples was then read, averages calculated, and then recorded as "cleaned reflectance."

Preparation of Detergents for Test

The instructions for mixing the detergents under test were followed explicitly wherever these were furnished by the manufacturer or compounder. In cases where directions were missing, the detergent was mixed in the proportions of 72 g of the dry mixture to 1 gal of water. This was the concentration of the detergent used to establish the standard and was found by observing the cleaning of a considerable number of customers' rugs through a commercial cleaning plant.

In several instances it was noted that a detergent failed when used according to directions, but when the concentration was increased to that of the standard, its performance was improved, usually to within the standard range.

Calculation and Evaluation of Data

Whiteness recovery (or fractional reflectance recovery) was calculated as follows:

$$\frac{g_c - g_s}{g_0 - g_s} \times 100 = \text{per cent recovery}$$

where:

g_c = green reading cleaned,
g_s = green reading soiled, and
g_0 = green reading original.

Since a few calculations of some of the same data of soil or grayness reduction made according to the Kubelka-Munk[1] relationship

$$K/S = \frac{(1 - R)^2}{2R}$$

K=etc, indicated greater discrepancies in correlation with visual results,

where:

R = observed reflectance,
K = coefficient of reflectivity, and
S = coefficient of light scattering

this type of calculation was not used further. However, from subsequent studies there are indications that this formula more truly represents actual soil removal conditions than the reflectance recovery alone as reported. Yellowness increase, an important factor in evaluating a rug detergent, was calculated from a formula furnished by the maker of the reflectometer,

$$Y = \frac{G - B}{G}$$

where:

Y = yellow,
G = green, and
B = blue.

[1] Paul Kubelka, *Journal*, Optical Soc. America, Vol. 38, pp. 448–457.
[2] H. Hemmendinger and Lambert, *Journal*, Am. Oil Chemists Soc., Vol. 30, pp. 163–168 (1953).

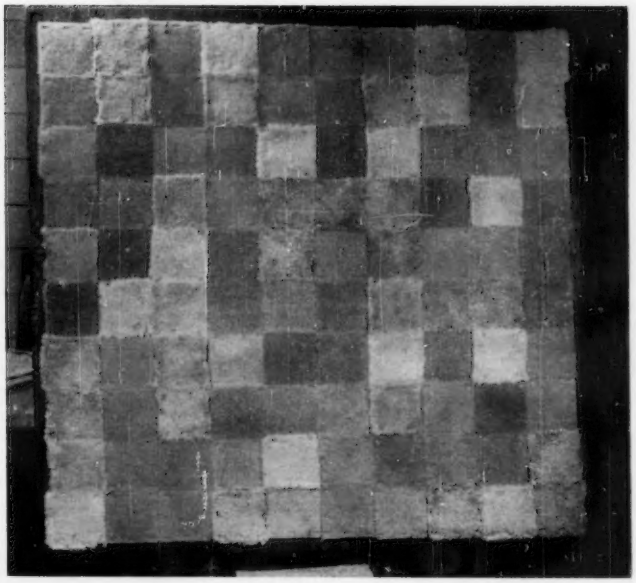

Fig. 3.—Soiling Plaque with Small Samples of Five Various Kinds of Carpetings Attached.

Actual change in yellowing could then be followed from the original to the soiled to the cleaned phase.

The performance of an arbitrarily chosen detergent was calculated from cleaning about 60 samples with it and, as a result, a mean whiteness recovery of 46 per cent was adopted as a reference point for comparing other detergents with respect to acceptability.

All detergents were ranked as equal, better than, or poorer than the standard performance of 46 per cent reflectance recovery. The spread of whiteness recovery for detergents equal to the assumed standard, as calculated by simplified analysis of variance methods, was about 6 per cent each way. Thus any detergent with a performance between 40 and 52 per cent was ranked as equal to the standard. Those above 52 per cent were ranked as better than the standard and those ranking below 40 per cent as poorer than the standard. Out of about 47 detergents tested in the tufted cotton program almost half failed in performance according to this test.

Actually the norm of 46 per cent reflectance recovery is low according to jury ratings in some experiments in establishing a customer acceptance grayness figure. For example, about 60 per cent recovery of the original whiteness was necessary before at least 65 per cent of the jury pronounced the rug acceptable. The jury rating for acceptance is nearly always confused by such factors as yellowing, tuft bloom, matting, linting, and other changes in texture not specifically related to soil removal. Training of a jury to disregard these extraneous influences is a difficult matter, whereas the instrumental values are additionally influenced by only the yellowness factor.

This yellowness factor is interesting in that if two samples have the same reflectance reading, the one with a greater amount of yellow component will usually be chosen as the more soiled by the visual observer. Although a numerical index can be calculated for the yellowness factor and yellowness can be seen, the author's laboratory has not yet been able to assess its exact effect in the rug soil picture, although work reported by Hemmendinger and Lambert[2] promises much help in this connection.

Conclusion

From the foregoing, it can be seen that performance testing of detergents is not a simple matter, and one of the most difficult aspects is correlation of test results with consumer (or jury) preference. There is a great need for this type of test and it is hoped that others may be inspired to attack and solve some of the problems yet remaining in the development of satisfactory performance tests for detergents.

The Development of Metal-Bonded Carbon Bearings

By Harvey B. Nudelman, Cord H. Sump, and Walter C. Troy

A new metal-bonded carbon bearing was developed to combine the desirable properties of carbon and metallic materials. Emphasis was placed on the interpretation of wear technology in bearing research.

THIS investigation developed a water-lubricated bearing material capable of performing in water at temperatures of 200 F and over.

Efforts were directed toward the interpretation of wear technology in the case of heated-water bearing applications. Materials combining the lubricating qualities of graphite with the high impact resistance and load-carrying capacity of metals were developed. A study of methods of combining and bonding carbon and metals was made. Solder, 70 nickel - 30 copper, and a 70 cobalt - 30 chromium alloy were the principal metals used. Very effective bearings were made with the cobalt-chromium alloy, as revealed by water-lubricated sleeve and thrust bearing tests.

Literature Survey

A survey of this literature indicated that conventional metal bearings have inferior performance characteristics in water.

The embedding of graphite grains in a metal to develop an antifriction material was attempted at least as early as 1903, for G. H. Clamer (1)[1] claimed to have filed a patent application for the idea at that time. He reported that some difficulty was experienced with babbitt metals and graphite in that "they were not sufficiently strong." During this period, it was revealed that a laminated composite of copper and graphite (2) was produced in Germany by electrodeposition.

Conditions for preparing a graphite-babbitt composite were outlined as early as 1910 (3). It was recorded that graphite-metal compositions could not be cast because the graphite was lost, but that shaping could be performed by machining. This process utilized the fact that some alloys become plastic at elevated temperatures. At these temperatures the graphite could be blended with the metal. Suitable alloys for the process were 90 per cent tin-10 per cent copper, 80 per cent tin-10 per cent copper-10 per cent antimony, 90 per cent tin-10 per cent nickel, and possibly copper-lead. In 1939 (4), F. K. Bezzenberger patented a similar concept by claiming a method of producing composite metallic articles by blending in non-alloying materials while the mixture was maintained at a temperature between the liquidus and the solidus of the alloy.

In the period of 1917 to 1924, a number of graphite-metal bearing compositions were introduced in commercial production. "Durex" (5, 6), a product of the General Motors Corp., was introduced as a copper-tin-graphite-bronze. No details of manufacture were given, but the composition was reported in 1937 (7) as 83.22 per cent copper, 10 tin, and 4.7 to 4.4 carbon. The General Electric Co. developed a bearing material known as Genelite (8), which was reported to have as high as 40 per cent graphite by volume. This material was prepared by mixing copper, lead, and tin oxides with graphite, and then heating to effect a preliminary reduction treatment. Finally, the reduction product was cold pressed at high pressures and resintered. The composition of Genelite was stated to be 13.72 per cent tin, 70.18 copper, 9.00 lead, 1.47 zinc, 0.055 phosphorus, 0.22 iron, and 5.35 graphite (7). It was described as having low tensile strength and comparatively high compressive strength. An impregnated graphite known as Graphalloy (9, 10) was introduced at this time also. This material was prepared by superheating copper or babbitt above its melting point in the presence of the graphite material to be impregnated. The graphite was said to have increased in weight by 150 per cent, with the metal content at 25 per cent by volume.

Mention should be made of the 10 per cent tin-bronze bearings that contain on the order of 2 per cent −200 mesh graphite. These bearings can be pre-

HARVEY B. NUDELMAN, Watertown Arsenal, Watertown, Mass., with the Foundation when this work was done, acted as project engineer on the metal-bearing development program. A metal-Teflon bearing was developed for service in heated water with his assistance.

CORD H. SUMP, supervisor, powder metallurgy research, Armour Research Foundation, Chicago, Ill., has, apart from a consistent emphasis on powder metallurgy, spent many years in study of wear, bearings, friction materials, rod mills, grinding wheels, etc.

WALTER C. TROY, Hunter Engineering Co., Riverside, Calif., formerly with the Foundation, has worked on development of high-duty brakes for electric motors for network protectors; friction studies in bearings for abrasion studies to develop materials for earth working; and development of shoe materials for aircraft catapults.

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[1] The numbers in parentheses refer to the list of references appended to this paper.

pared by pressing metal powder mixtures at pressures less than 20 tons per sq in. and sintering at 1472 F for 20 min (7).

In the examination of bearing literature, the corrosion of these materials in water was included also. It has been suggested (11) that the movement of metal through water can fracture the water molecule so that hydrogen and hydroxyl ions are released as severely corrosive agents. Gas nucleation on metal surfaces can cause cavitation and subsequent corrosion. This phenomenon together with increased ionization might serve to explain in part the corrosive action of hot water. The increase of chemical activity of water can be illustrated by examining the behavior of aluminum in heated water. The metal degenerates into aluminum oxide powder after a relatively short exposure at high temperature, but is quite stable for use in ordinary cooking activities.

Considerations in Material Selection

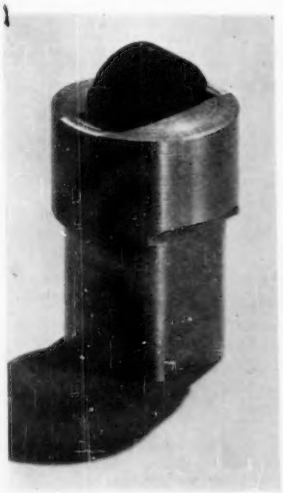
At first only a maximum temperature of 200 F was considered, and it appeared that the problem essentially was close to conventional water lubrication engineering problems. The temperature was somewhat higher than usual, but not sufficiently high to manifest the unusual oxidizing and disintegrating characteristics of oxygenated water at still higher temperatures. Considering the antiseizure and corrosion resistance properties of graphite, it appeared sound to continue regarding carbon as a physically favorable material.

For service conditions, however, a metal matrix providing corrosion resistance, impact strength, and good bearing characteristics was required. Corrosion resistance would be provided presumably by a metal or alloy forming a passive film. Such films are generally oxides and should preferably be self-repairing under exposure conditions. Impact resistance, if not inherent in the material, might be improved by alloy modification.

Preliminary Studies of Metal-Carbon Composites

Experimental work was initiated with the study of several methods of combining metals with graphite. In view of the possibility of operating bearings at 200 F or below, the lead-tin alloys were studied as potential matrix materials. Several processes were investigated to determine satisfactory methods of preparation. Conventional casting techniques were not usable because of the large differences between the specific gravities of most metals and graphite. These differences prevent dispersion of the graphite through the molten metal.

The process outlined by Bezzenberger (4) was tried as a means of producing a lead-tin-bonded graphite body. A 40–60 solder alloy was chosen because of the wide temperature range between solidus and liquidus. After heating the solder to 410 F enough preheated -6 $+28$ mesh graphite was added to form a 50 per cent by volume composite with the solder. The mixture was stirred in a heated steel mold at a temperature between the solder liquidus and solidus, and an extrusion pressure of 400 psi was applied by a preheated plunger. The extrusion was successful, but there was some tendency of the coarse granular carbon to tear the metal matrix during extrusion.



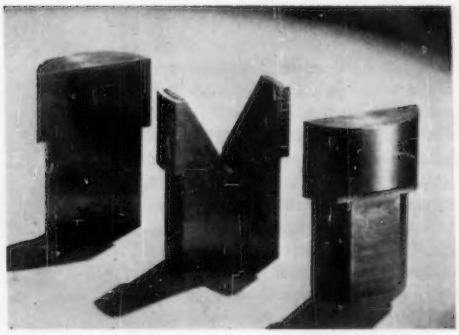


Fig. 1.—Non-Standard Impact Testing Fixture. This holder permits the use of readily prepared ½ in. round compacts for rapid impact evaluation.

By vacuum impregnation of a confined bed of graphite, satisfactory solder-graphite materials were prepared. The process consisted of confining a bed of -6 $+28$ mesh graphite particles with wire gauze in a vertically supported heated tube. The tube was lowered into a pool of molten solder, and vacuum was supplied at the upper end. Examination of the solidified composite showed excellent infiltration of the solder about the graphite particles. Particles of titanium-coated (12) graphite were confined in a tube and infiltrated in the same manner as the previously prepared uncoated graphite. The fractured surface indicated the presence of bonds at the graphite-titanium-solder interfaces.

Agitation during solder solidification was effective also in preparing a satisfactory solder-graphite composite. This was accomplished by: (1) heating a mixture of graphite and 50–50 solder above the melting point of the solder, (2) keeping the graphite submerged with a plunger, and (3) vibrating the container until solidification was complete.

Another technique consisted of confining the graphite particles in a heated die, adding molten solder, and finally squeezing out the excess solder. The disadvantage of this method was that the excessive metal extrusion caused preferential segregation of the carbon particles used in formulating the body.

These experiments together with several trials with powder compacts served as a means of developing some familiarization with the techniques and processes that might contribute to the development of metal-bonded carbon bearing composites.

Corrosion-Resistant Matrix for Metal-Carbon Composites

A 70 per cent nickel 30 per cent copper alloy was selected first as a possible matrix material for service above 200 F primarily for its corrosion resistance shown in condensers and heat exchangers at elevated temperatures. A suggested explanation of corrosion stability was the relatively high nobility of copper together with the ability of nickel to form a passive oxide film (13). In addition, these alloys have high impact strengths and low solubilities for carbon. Addition of 1 per cent by weight of ferromanganese to the powder produced

a ductile nickel-copper compact when hot pressed in air. It was assumed that the ferromanganese performed during hot pressing in much the same manner as manganese additions added to nickel-copper alloys.

Nickel-copper composites were prepared using very coarse graphite particles (−6 +28 mesh). The poor edge strength that resulted was attributed in part to the segregation of the graphite particles. The compacts were prepared by hot pressing a 40 per cent graphite, by volume, metal powder mixture at 2000 F and 6000 psi. When the carbon particle size was reduced to −28 +72 mesh, the distribution and impact strength was improved for the same composition. Carbon particles below 100 mesh generally impaired the mechanical properties.

Examination of an oil-blended compact revealed improved graphite distribution for a 50 per cent by volume composition. The limit of −28 +72 mesh graphite additions appeared to be about 85 per cent by volume. When the carbon addition was increased beyond this point, the presence of a continuous metal matrix was in doubt.

Impact Studies of Metal-Carbon Bodies

Of the mechanical weaknesses of carbon as a bearing material, one is its low impact resistance. With this in mind, attention was directed toward the development of some method of rapidly ranking the impact resistance of experimental bearing materials with graphite.

Graphite was impact-tested against nickel-copper-graphite composites. A preliminary test consisted of dropping a 1.7-lb steel ball on a $\frac{7}{8}$-in. round specimen resting on a steel block. The height of free fall required to crack the sample was used as an index of impact strength. A similar test was used for evaluating plastics by the Naval Air Experimental Station [14]. This test indicated that a 60 per cent by volume graphite – 40 per cent by volume nickel-copper compact might be superior to graphite in impact strength.

Later a Sonntag Universal Impact Testing Machine was adapted for testing metal-graphite composites by the use of a special specimen holder (Fig. 1). The specimen size was standardized at $\frac{7}{8}$-in. diameter and $\frac{3}{8}$-in. thick. This size was adopted because it was convenient to prepare by hot pressing. The specimen was supported vertically and broken at its midsection by an Izod hammer adjusted usually for the 25 ft-lb scale. This test showed excellent reproducibility of results and served as a method of quantitative measurement throughout the research program. (See Tables I, II, and III.)

TABLE I.—IMPACT PROPERTIES OF GRAPHITE AND HOT PRESSED 70 NICKEL - 30 COPPER - GRAPHITE.

Material	Composition	Component Under Study	Non-Standard Impact Value, ft-lb
Graphite	100% "AGR" grade (as received)	All graphite body	1.00
Nickel-copper-graphite	60% graphite by volume, −28 +72 mesh. 2 per cent polybutene addition. Primary metal powders. Desulfurizer added.[a]	Polybutene addition	6.58
Nickel-copper-graphite	60% graphite by volume, −28 + 72 mesh. 2 per cent 10W oil addition. Prealloyed Monel powder. Desulfurizer added.[a]	SAE 10W oil addition	5.45
Nickel-copper-graphite	60% graphite by volume, −28 + 72 mesh. 2 per cent polybutene addition. Prealloyed Monel powder. Desulfurizer added.[a]	Prealloyed Monel powder	4.10
Nickel-copper-graphite	60% graphite by volume, −28 + 72 mesh. 5 per cent by weight iron coating on graphite. 2 per cent polybutene addition. Primary metal powders. Desulfurizer added.[a]	Iron coating on graphite	5.90
Nickel-copper-graphite	60% graphite by volume, −28 +72 mesh. 5 per cent by weight titanium coating on graphite. 2 per cent polybutene addition. Primary metal powders. Desulfurizer added.	Titanium coating on graphite	10.30

[a] 1 per cent Ferromanganese.

TABLE II.—MECHANICAL PROPERTIES OF COBALT-CHROMIUM-CARBON COMPOSITES.[a]

Material	Metal, per cent by weight	Metal, per cent by volume	Average Impact Strength, ft-lb (non-standard test)	Average Compressive Strength, psi[c]
Graphitar 14	...	...	2.2	22 200
Co-Cr-C	60.5	30.1	6.75	21 800
Co-Cr-C	65.1	35.1	...	34 000
Co-Cr-C	67.1	37.3	7.5	...
Co-Cr-C	75.7	46.7	>25[b]	...
Co-Cr-C	76.7	48.0	...	52 700
Co-Cr-C	84.8	60.6	25.5	...
Co-Cr-C	87.4	66.1	>60	86 800
Co-Cr-C	89.7	71.0	...	119 400
Co-Cr-C	100.0	100.0	>60	193 000

[a] Carbon −72 + 100 mesh, 70 Co-30 Cr alloy binder.
[b] Samples marked > did not fracture.
[c] Compression specimens 0.5 in. high, 0.625 in. diameter.

Preparation and Testing of Nickel-Copper-Carbon Bearings

It was decided to subject nickel-copper-carbon composites to the water-lubricated sleeve-journal bearing test at Battelle Memorial Inst. The preparation of bearing specimens[2] involved the design and assembly of large-scale hot-pressing equipment. Sufficient die section for punch confinement and powder fill was provided by a 6-in. round graphite die $6\frac{3}{8}$ in. long to press a $1\frac{3}{4}$-in. diameter specimen. A well was drilled in the upper punch to within $\frac{1}{8}$ in. of the punch-powder interface to provide adequate temperature control with a chromel-alumel thermocouple. The bearing test specimens were hot pressed at 2200 F and 6000 psi. The volume percentage of graphite was maintained satisfactorily between 58 and 60 per cent with proper temperature control.

TABLE III.—MECHANICAL PROPERTIES OF COBALT-CHROMIUM-CARBON COMPOSITES.[a]

Metal, per cent by weight	Metal, per cent by volume	Non-Standard Test, Impact Strength, ft-lb	Compressive Strength, psi[c]
80.7	53.7	...	49 800
84.0	58.8	>60[b]	...
85.7	61.9	...	111 000
86.4	63.5	37.75	...
86.6	63.6	30.60	...
87.3	65.4	...	118 000
87.4	65.8	...	106 800
87.5	66.0	43.40	...
88.3	68.0	...	125 000
89.2	69.7	...	121 600
90.0	72.0	...	131 000
94.3	83.0	>60	...

[a] Carbon −100 + 150 mesh; 70 Co-30 Cr alloy binder.
[b] Samples marked > did not fracture.
[c] Compression specimens were 0.5 in. high, 0.625 in. in diameter.

Several bearing composites were forwarded to the Battelle Memorial Inst. for testing as water-lubricated sleeve bearings. The bearings consisted of 58 per cent granular graphite by volume

[2] 1.246 + 0.000 in. −0.001 in. inside diameter, 1.50 in. outside diameter approximately for press fit, 1.0 in. long. 4 mils diametral clearance with shaft.

and 42 per cent nickel-copper as a 70-30 alloy. Two mesh sizes of graphite were utilized: −35+72, and −72+100 mesh, respectively. In running this test, the bearing in the form of a thin shell was press-fitted in a stainless steel retainer.[3] Weights on an attached arm extending through the bottom of the test container loaded the bearing. A belt-driven pulley mounted on the journal provided the driving force for a shaft speed of 10 ft per sec. A microswitch was positioned so that it would be tripped by the loading arm if high torque developed.

Upon testing, both bearings containing fine carbon seized immediately. The bearing prepared with coarse graphite particles wore rapidly at light loads. The nickel-copper matrix provided the predicted corrosion resistance, but failed to prevent welding. The alloy appeared to be too noble to develop a pronounced surface oxide and presented instead a surface favorable for welding and seizure. Microscopic examination showed bright clean metal surfaces.

Development of Cobalt-Chromium-Carbon Bearings

Another factor considered at this time was the wear resistance of the matrix. According to test results, the nickel-copper alloy was much too soft to withstand wear. A harder alloy appeared to offer increased wear resistance. In wear technology, the Modell number (15) concept states that wear resistance is directly proportional to the hardness and inversely proportional to the elastic modulus. The modulus was reported to be lowered by interruptions of the metallic matrix such as porosity. An increase in matrix hardness of a porous structure should provide greater wear resistance. The presence of carbon in the composite plays little part in contributing to the mechanical strength of the body. But carbon might be considered in this instance as a means of establishing voids in the body and thus lowering the elastic modulus.

An all-chromium matrix would have been satisfactory if only surface oxide development and corrosion resistance were considered. The general brittle character of this metal, however, would result in very poor impact properties. Attention was directed then to experimentation with cobalt and chromium alloys. This work yielded an alloy (80 per cent cobalt, 20 per cent chromium) with a Rockwell hardness C scale of 25 when hot pressed from mixed primary powders. A Rockwell hardness C scale of 42–45 was obtained by increasing the chromium content to 30 per cent. Alloys of greater chromium content were considered undesirable because of increased brittleness. The addition of 56 per cent by volume of granular carbon to this alloy in hot pressing at 2200 F (Fig. 2) did not have any noticeable effect on matrix hardness. Diamond pyramid hardness measurements of the matrix were taken to determine the effect of possible carbide formation.

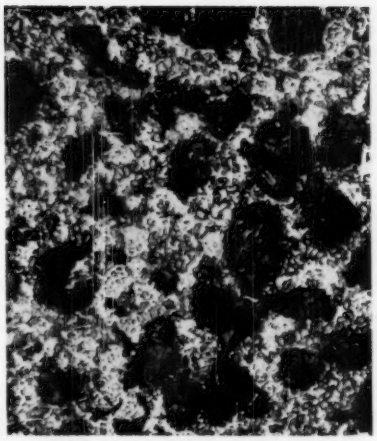


Fig. 2.—Cobalt-Chromium-Carbon, Composite, Equal Volumes of Carbon and Metal Composition 70 per cent Cobalt, 30 per cent Chromium by Weight. Etchant, chromic acid, 50.

Preparation and Properties of Cobalt-Chromium-Carbon Bearings

No significant changes in hot pressing techniques were required to prepare cobalt-chromium-carbon composites. The pressing conditions for producing the best mechanical properties and carbon distribution were found to be 2200 F and 6000 psi. Calcined petroleum pitch base coke was substituted for granular graphite. Hard carbon was considered to be superior in hardness, compressive strength, and general wear characteristics. In addition, it was believed that the wear products would act to smooth the bearing surface. The chromium constituent of the metal phase could form a diffusion bond with carbon by the formation of carbide at the interface. The impact resistance of cobalt-chromium-carbon bodies containing 53 to 56 per cent by volume granular carbon was found to be about five times greater than high-strength carbon[4] using the modified non-standard Izod test. The metal-carbon body developed an impact strength of 10.6 ft lb compared with 2.1 for special high-strength carbon.

Specimens were prepared for testing as water-lubricated sleeve bearings.[5] The standard conditions for hot pressing were 2200 F and 6000 psi. The powders used in specimen preparation were 300 mesh cobalt, 325 mesh electrolytic chromium, and −72+100 mesh hard carbon. The compact density was in the range of 4.0 g per cu cm corresponding to a composition with 70 per cent carbon (Fig. 3). The per cent of carbon was increased over previously prepared specimens with the objective of creating a more suitable bearing surface with maximum interruption of the metal phase. It was decided to hard-chromium plate the type 304 stainless steel shafts and in this way provide a mate-

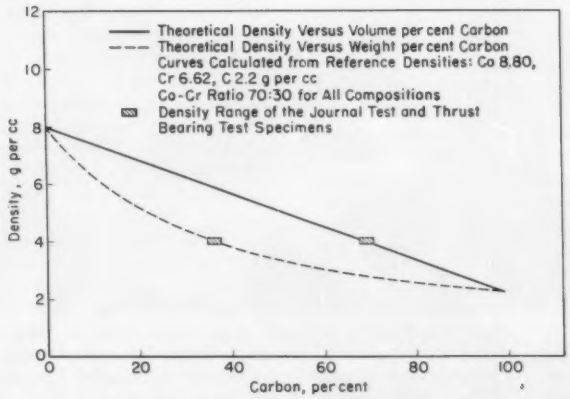


Fig. 3.—Density *Versus* Composition For Cobalt-Chromium-Carbon.

[3] R. W. Dayton, C. M. Allen, H. A. Van Dyke, "The Performance of Water-Lubricated Bearings," Battelle Memorial Institute Report, U. S. Atomic Energy Commission. *Report BMI*—843.

[4] Carbon-impregnated graphite.

[5] 1.246 + 0.000 in. −0.001 in. inside diameter, 1.50 in. outside diameter approximately for press fit, 1.0 in. long. Test evaluation phase was performed at Battelle Memorial Institute.

rial with known wear characteristics in oxygenated water.

Machining operations such as drilling and turning required carbide tools. Surface finish was found to be improved by following these operations with grinding. This procedure resulted in a surface having far less metal smear. The metal-carbon composites were bored to a press fit in the housings. Boring to within 20 mils of specified size and final grinding completed the bore finishing operation. Grinding avoided tearing the surface, removing carbon, and excess smearing of the metal phase over the carbon. In addition, the sharp corners of the bearing were relieved to protect the bearing from any bending or misalignment of the shafts. Test specifications included a 4-mil diametral clearance under test conditions. Shaft expansion at test temperature was calculated, but bearing and housing expansion was determined experimentally. Clearances at 200 F proved to be the same as those at room temperature, which simplified this operation considerably.

Sleeve-Journal Tests at Battelle Memorial Institute

Two cobalt-chromium-carbon composites were tested as water-lubricated sleeve bearings for 100 hr in 200 F water with increasing loads up to 48 psi. The final test water was reported to be very clean. This lack of contamination seemed to indicate that very little wear or corrosion occurred at the contact surfaces.

Upon return of the cobalt-chromium-carbon test bearings and test shafts, it was noted that one bearing made contact essentially only at one end, as indicated by the small polished area there (Fig. 4). There was no visible evidence of metal pick-up or wear, but an average dimensional increase on the order of 0.0001 in. was recorded. This slight change in dimensions might have resulted from the thermal experience at 200 F. The maximum test pressure was 48 psi, which assumed the load to be distributed uniformly. However, the unequal stress distribution caused the pressure to be much greater on the relatively small areas of contact. Most of the wear surface of the bearing was unaffected. The mating shaft revealed polishing at the ends of the bearing contact area. Both shafts showed a slight increase in diameter in their entire lengths. Again, this might have been the result of thermal experience at 200 F.

[6] This evaluation phase was a portion of the development work performed at the Franklin Institute.

[7] The Franklin Institute Report of March 5, 1951 to June 30, 1953. Prepared under Subcontract 14-313 for Westinghouse Electric Corp., APD.

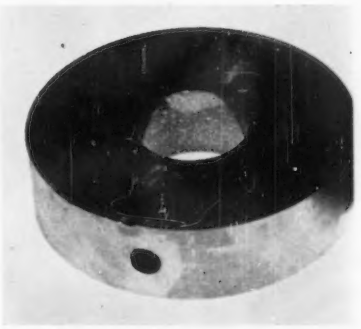


Fig. 4.—Cobalt-Carbon Bearing in Housing, Housing type 304 stainless steel. The bearing ran against a hard-chromium plated shaft for 100 hr in 200 F water at a maximum load of 48 psi. The light area of the bearing is the polished area of contact. The loading of this area was greater than the nominal value of 48 psi, which assumed uniform load distribution.

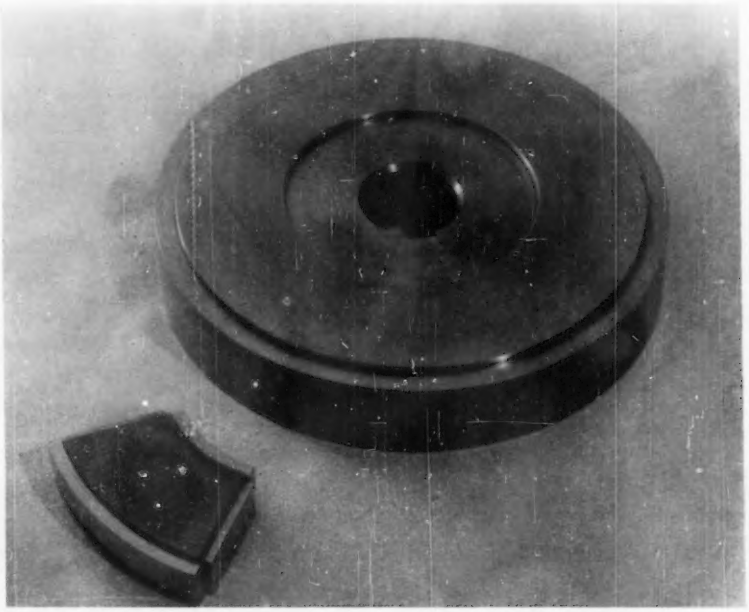


Fig. 5.—The Thrust Bearing Test Runner Is Hard-Chromium Plated Type 322 Stainless Steel. Bearing is one of six cobalt-chromium-carbon thrust bearings. Approximately one-third size.

Thrust Bearing Tests at the Franklin Institute

Following the satisfactory journal bearing tests, it was decided to consider a more rigorous test, namely, a start-stop test in a thrust bearing apparatus.[6] In this test, bearing materials were tested in the form of segmented shoes (Fig. 5). In order to retain a basis of comparison with the sleeve-journal test, it was agreed to test the material against hard-chromium plated stainless steel.

A 3000 cycle Ajax induction unit was used to provide heating power for hot pressing. In order to protect the press from radiant heat during the hot-pressing cycle, the ram guides and the upper and lower platens were water cooled. To facilitate cooling, water was passed through copper tubing brazed to tinned steel sheet. The sheets were bolted around the ram guides and attached to the upper and lower platens. This provided cooled metal screens to protect the exposed areas of the press during heating. The $3\frac{7}{8}$-in. diameter slugs were prepared by hot pressing at 6000 psi and 2200 F. The average heating time was 1 hr, and the load was not maintained once it was applied at temperature.

The densities of the composites were determined after pressing to insure uniform mechanical properties. The densities of the six composites ranged from 3.90 to 4.15 g per cu cm. This corresponded to the densities of the journal bearings (3.93 and 4.10 g per cu cm).

Six bearings were machined and fitted to Type 304 stainless steel bearing retainers. The running surfaces were rotary ground to provide the best possible surface.

Lapping operations were performed by the Lapmaster Division of the Crane Packing Co. A convex curvature[7] was developed in the bearing segments by having the bearing segments mounted

on a flat plate and then lapping on a concave plate using type 1800 aluminum oxide. Further hand lapping to greater convexity was performed by the Franklin Inst. to favor water film development. Two stainless steel runners were rotary ground and hard-chromium plated. The runners were lapped to 2 to 3 helium light bands of flatness.

After the experimentation with surface contour, the components were run in cold water and exhibited smooth-running characteristics. In raising the water temperature to 200 F, high torque developed immediately. Examination showed that failure was associated with bearing surface preparation. The nature of the surface, with continuous metal confining carbon, resisted early attempts to reduce roughness. Grinding and lapping undercut the carbon, the weaker of the two components. The lapping process, while producing maximum convexity, did not remove material uniformly to relieve the surface irregularity. Metallographic examination revealed that the resulting surface consisted of metal areas in relief. This rough surface was believed to be responsible for the initial failure, as it reduced the effectiveness of the water film. Under similar conditions, water films have been maintained on materials with less surface roughness. The relatively rough surface of the cobalt-chromium-carbon material effectively reduced the thickness of the water film, resulting in metallic contact between bearing high points and the runner surface. Asperities on the bearing surface probably welded to the runner and were torn loose. The high torque noted presumably was caused by this action. The presence of these particles between the bearing surfaces resulted in the abrasion of the runner.

The bearing shoes, being unaffected except for score marks, were replaced in the test apparatus after the removal of the loose metal particles embedded at the end of the score excursions. In the next test, an alumina runner was used instead. Five hundred start-stop cycles were concluded successfully, and the components were examined. No wear was in evidence on the runner. Darkened bands at the outer edges were visible, but this was believed to be due to bearing vibration. Traces of wear products were discovered in the alumina, which was essentially a sintered material with discontinuous porosity. The bearing shoes developed a new pattern of wear. Circular polished areas were produced by the test in the central portions of the shoes (Fig. 6). Other areas were unaffected. The wear on the bearing surfaces was slight, but the degree of flatness was increased. In effect, the alumina runner acted as a tool honing the bearing surfaces. Metallographic examination of a representative shoe revealed several important surface features. Only an estimated 15 per cent of the metal present at the surface was in contact with the runner. This was an indication of the unsuitability of the surface preparation. It was noted that the carbon was at the surface only in isolated areas.

The bearings were retested against a new chromium-plated runner prepared in the same manner to determine the effect of the surface created by the alumina runner on bearing characteristics. As seizure was associated with the failure of the rough surface to maintain a water film, the alumina-polished surface would be expected to show improved bearing properties. One hundred start-stop cycles were completed successfully with low torque, which substantiated the opinion that failure was related to surface finish. The reduction in surface roughness produced previously by the alumina runner was sufficient to maintain a water film and result in smooth running characteristics. Examination of the bearings revealed no significant changes as a result of testing. There was no evidence of wear; no wear products were visible on the surface, and the runner was unaffected except for scoring. This scoring, however, was presumed to result from the dislodgement of particles from the residual score marks on the bearing surfaces.

Experimental work was done toward the objective of preparing surfaces of decreased roughness on cobalt-chromium-carbon composites.[8] Using a lead-base alloy polishing lap and type 2500 silicon carbide, samples having an average surface finish of 3 to 4 microinches rms were prepared (Fig. 7).

It was believed that a further test of this material with more suitable surface preparation would give a better indication of the potentialities for thrust bearing service. The modified surface resulting from the alumina runner test was maintained on subsequent lapping operations. The shoes were mounted on a flat plate and lapped on a concave lapping plate using type 1800 alumina to develop a convex surface on the bearings. Surface imperfections from previous tests were removed with few exceptions. The central portions of the bearings were flattened by using a flat lapping plate. Mounting was accomplished by loading through ball bearings mounted on the underside of the retainers. Finishing operations were performed using a lead alloy base polishing lap and type 2500 silicon carbide as the abrasive. This technique polished the central flat portions of the bearings to an average of 3 microinches rms and

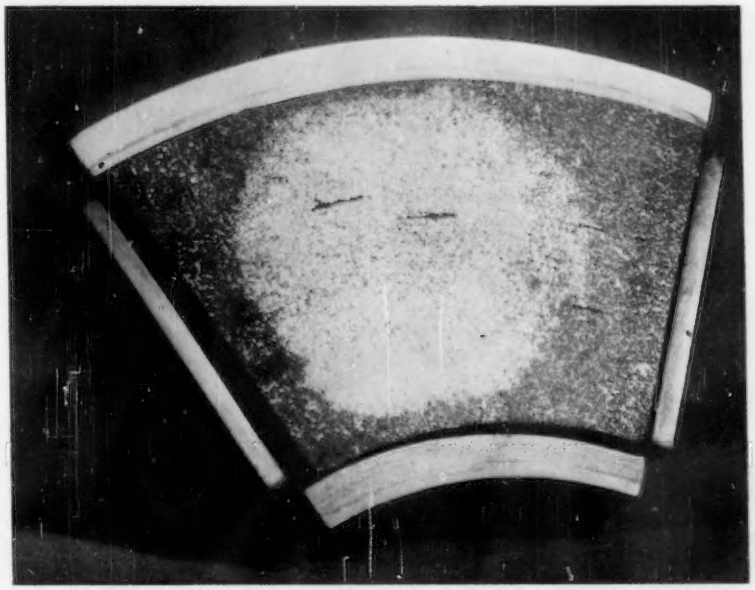
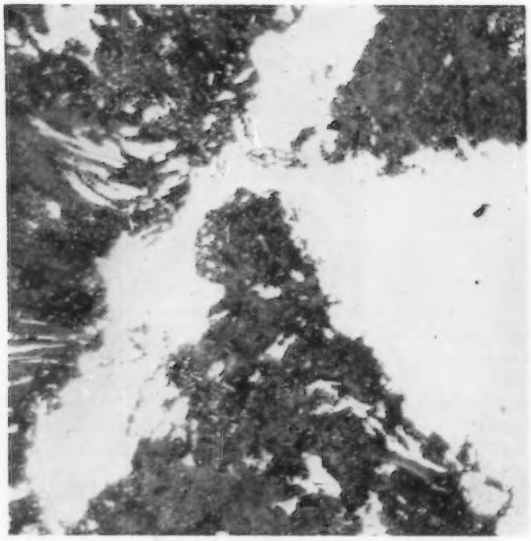


Fig. 6.—Running Surface of a Cobalt-Chromium-Carbon Thrust Bearing, 70 30 Cobalt-Chromium Alloy Binder, Carbon 65 Per Cent by Volume. Bearing appearance after running in 200 F water against an alumina runner. The light circular area is the new wear pattern produced by running against alumina runner. Residual scratches from first test against chromium plate may be seen as dark lines across shoe surface.

[8] This work was performed at the Lapmaster Division of the Crane Packing Co.



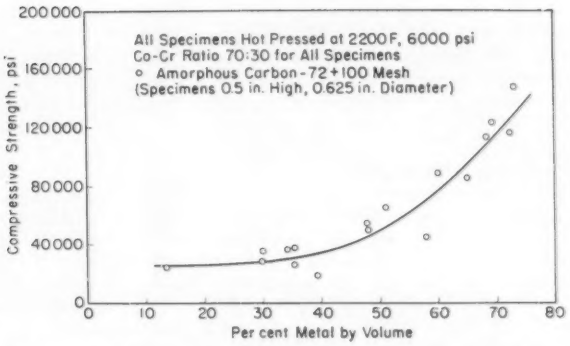


Fig. 8.—Compressive Strength of Cobalt-Chromium-Carbon Composites as a Function of Metal Binder Content.

Fig. 7.—Lapped Surface of a Cobalt-Chromium Composite, 70/-30 Cobalt-Chromium Alloy Binder, Carbon 65 Per Cent by Volume. The carbon phase composes the dark areas. Unetched, × 500.

duplicated closely the surface "polished" by the alumina runner. The removal of score marks and the decreased surface roughness represented a refinement in bearing properties while the effect of decreased convexity was unknown.

On re-testing, this combination ran successfully with low torque for 100 start-stop tests. Some scoring was noted in the wear track, however, it would appear that metal-to-metal contact is difficult to avoid in thrust bearing operation without additional lubrication by techniques such as pressurizing. Another approach would be the replacement of the runner with materials such as nitrided titanium or nitrided stainless steel with modified surface characteristics. These tests have demonstrated that the metal-bonded carbon bearing material can operate successfully as a water-lubricated thrust bearing under conditions of low torque and can accommodate itself to local damage without disturbance to the running characteristics of the mechanism. It would appear to be essential that metal-to-metal contact be avoided by modification of the runner surface.

Mechanical Properties of the Cobalt-Chromium-Carbon Composites

The effect of metal binder content on the impact resistance and compression strength of cobalt-chromium-carbon composites was examined. Compression and impact specimens of varying metal-binder content were prepared by hot-pressing techniques. The ratio of cobalt to chromium (70–30) was not varied, for it provided the highest hardness without the brittleness associated with alloys of higher chromium content. The results of this investigation appear in Table II and Fig. 8.

The effect of finer mesh sizes of carbon on the mechanical properties of this system was investigated also. Finer carbon particles would have been required if bodies of higher metal-binder content proved desirable, as a problem of adequate distribution is involved in this instance. The tabulated data appear in Table III.

Conclusions

This investigation carried through development stages a successful water-lubricated bearing material for service at 200 F and over. Material design efforts were directed toward the embodiment of the combined impact resistance of metallic materials and the anti-friction properties of carbon. An interrupted structure of metal-bonded carbon was developed on the basis of theoretical consideration and experimentation. This material demonstrated greater impact strength than carbon, the material currently in use for this application. Sleeve and thrust bearing tests served to show that in addition to improved mechanical properties, adequate bearing characteristics had been retained. Hardness proved to be a necessary requirement of the metallic matrix. It was demonstrated that for thrust bearing applications, the surface finish of metal-carbon composites ranks at least equally in importance with surface contour for maintaining a hydrodynamic film. Without this film, it is doubtful if wear can be prevented if metal-to-metal contact is established.

The authors recommend the 70 cobalt 30 chromium alloy matrix with carbon additions of 60 to 70 per cent by volume for further bearing development. This composition increases the usefulness of the cobalt base alloys in this application. Hot pressing as a fabrication technique today is a commercial reality. Possibly flash-sintering by resistance heating is an alternate production method. Apart from this, a large saving in critical cobalt alloy is realized by the addition of 60 to 70 per cent by volume carbon.

Acknowledgment:

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Carl Swartz contributed to the formulation of the basic bearing concept and to the development of the successful bearing composition.

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Influence of Exposure Conditions on the Accelerated Durability Testing of Asphalt

By L. R. Kleinschmidt and S. H. Greenfeld

Three different coating-grade shingle asphalts were exposed in accelerated durability machines to six different cycles, varying primarily in the temperature of the spray water and the frequency and duration of the washing periods. Although the durability of each asphalt was different for each cycle, within the precision of the data the order of their failures was the same. In general, the degree of differentiation among the asphalts increased as the severity of the cycle decreased. Of the cycles investigated, the one in which the specimens were exposed to 9 continuous minutes of cold-water spray every hour for 21 hr a day seemed most effective for differentiating among the asphalts.

ASPHALTS, being relatively inert organic materials, degrade very slowly when exposed to the weather under normal conditions of use. Because there are wide differences in the durability of asphalts, a rapid method for distinguishing among them has long been sought. For a number of years accelerated durability tests have been used successfully for this purpose. Numerous combinations of light, water, heat, and thermal shock (the principal factors involved in the degradation of asphalts) have been proposed and used but unanimity has never existed as to the most effective combination and sequence of these factors.

Because of the divergence of opinion concerning the accelerated testing of asphalt coatings, a series of exposures was made to compare a number of exposure conditions. These exposures varied mainly in the frequency and duration of the spray periods and in the temperature of the spray water.

Historical Background

In 1928, Walker and Hickson[1] reported on an apparatus and test procedure for the accelerated durability testing of organic protective coatings. Strieter pioneered the application of this type of testing to asphalts, publishing his first report in 1930.[2] In 1933, Subcommittee VIII on Accelerated Tests on Roofing Materials of ASTM Committee D-8 on Bituminous Waterproofing and Roofing Materials published Strieter's findings as a proposed "Recommended Practice for Accelerated Weathering Test of Bituminous Materials".[3] Because of a desire to include more frequent spray periods, the proposed method of test was modified in 1937[4] to include a third cycle. This added cycle[5] had been used by Snoke and Gallup[6] in their studies of the weathering behavior of mineral-surface

NOTE.—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the author. Address all communications to ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa.

[1] P. H. Walker and E. F. Hickson, "Accelerated Tests of Organic Protective Coatings," *Journal of Research*, Nat. Bureau of Standards, Vol. 1, No. 1, July, 1928, p. 1 (*RP* 1).

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[4] Report of Subcommittee VIII of Committee D-8, *Proceedings*, Am. Soc. Testing Mats., Vol. 37, Part I, p. 419 (1937).

[5] "Cycle," as used in this paper, refers to the series of operations covering a period of 24 hr.

[6] H. R. Snoke and B. L. Gallup, "Accelerated Weathering Tests of Mineral-Surfaced Asphalt Shingles," *Journal of Research*, Nat. Bureau Standards, Vol. 18, No. 6, 1937, pp. 669–683 (*RP* 1002). Snoke and Gallup omitted the cold period.

The Authors . .

LAWRENCE R. KLEINSCHMIDT has worked with bituminous materials at the National Bureau of Standards since 1928. Up to 1946 he was engaged in physical testing of roofing, waterproofing and road materials and since 1946, in determining the constitution and weathering properties of asphalt.

SIDNEY H. GREENFELD, Asphalt Roofing Industry Bureau Research Associate at the National Bureau of Standards, has been working on the mechanism of asphalt degradation and stabilization since 1949.

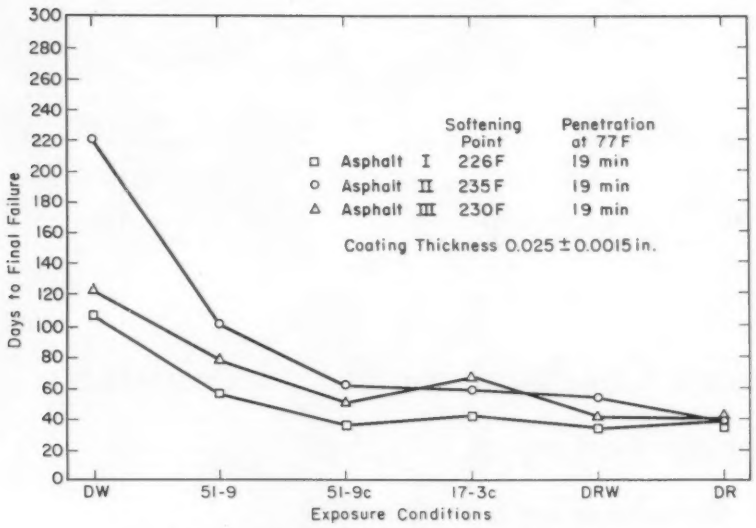


Fig. 1.—Days to Final Failure *versus* Exposure Conditions.

shingles in an accelerated weathering machine. The Society in 1939, issued Tentative Recommended Practice for Accelerated Weathering Test of Bituminous Materials (D 529),[7] which is still in effect today. It includes three recommended cycles containing the sequences of operations reported in Table I.

TABLE I.—ASTM CYCLES.

Cycle	A (1933),[a]	B (1937),[a]	C (1939),[a]
Water—dark, hr	...	¼	...
Cold, hr	1¾	1¾	...
Water—light, hr	...	4	22
Water—dark, hr	1	½	...
Light, hr	1½	17	...
Water—dark, hr	2	...	...
Light, hr	16½	...	...
Cold, hr	...	...	1¾
Inactive, hr	1¼	½	¼

[a] Year published.

In all of the cycles in Table I, the specimen-holding drum rotated once every 20 min. In the more recent models of the accelerated durability machines, the drum rotates at 1 rpm and the sprays are controlled by timing devices. These changes, which made the operation of the machines more flexible and automatic, also changed the over-all effect of the water-light ratio sequence.

[7] 1955 Book of ASTM Standards, Part 3, p. 1723.

[8] Weather-Ometer, Type HVDXL, Atlas Electric Devices Co., Chicago, Ill.

[9] S. H. Greenfeld, "A Method for Preparing Uniform Films of Bituminous Materials," ASTM BULLETIN, No. 193, October 1953, p. 193.

Methods

The asphalts included in this investigation were of the air-blown type normally used as the coating material for mineral-surfaced asphalt shingles. They were produced from crudes from widely separated fields. The softening points and penetrations of the coatings exposed are given in Fig. 1.

Apparatus

The accelerated durability machines were basically the same as the commercial "Single Arc Weather-Ometer"[8] having the same dimensions and operating in the same ranges of arc voltage (130 to 145) and current (15 to 17 amp). The spray water had a mineral content of less than 2 ppm and a pH of 6 to 6.2, obtained by passing tap water through commercial demineralizers. All pipes and fittings were of aluminum or stainless steel. The water was delivered at the spray nozzles at 25 ± 5 psi (gage).

Exposure Conditions

The specimens were exposed under the conditions described in Table II. The operations performed in a 24-hr period constitute a cycle, while shorter repetitive functions are termed sequences. Where letters are used to designate the cycle, they indicate the order of exposure to the various conditions. Thus "DW" represents a cycle in which exposure to 21 hr of dry light was followed by 1 hr of water spray. Similarly, "DRW" represents a cycle of 21 hr of dry light followed by 1 hr of refrigeration and 1 hr of water spray; while "DR" consists of 21 hr of dry light followed by 1 hr of refrigeration. Where numbers are used, they refer to the duration in minutes of dry light and light with water spray in the principal sequence of the cycle. Thus, cycle 51-9 contained a repeating sequence of 51 min of dry light followed by 9 min of light and water spray for 21 hr each day. The 51-9C cycle contained the same sequences, but utilized 40 F water instead of 77 F water. The 17-3C cycle had a repeating sequence of 17 min of dry light followed by 3 min of light and cold-water spray (40 F) for 21 hr. In the two or three hours each day in which the specimens were not exposed, they remained at ambient conditions while the accelerated durability machines were being serviced.

Procedures

The test specimens were prepared by the hydraulic press method developed by Greenfeld[9] and were exposed within 24 hr of their preparation. All coatings were nominally 2¼ by 5¼ in. in area and 0.025 ±0.0015 in. thick. They were supported on 2¾ by 6 by 0.065-in. aluminum panels.

TABLE II.—EXPOSURE CONDITIONS.[a]

Exposure Designation	Light		Refrigeration		Water Spray			Inspection and Maintenance Period	
	Time, hr	Maximum[b] Temperature, deg Fahr	Time, hr	Temperature, deg Fahr	Alone, hr	With Light, min	Minimum[b] Temperature, deg Fahr	Time, hr	Temperature, deg Fahr
DW	21	144	0	...	1[c]	0	77	2	77
DRW	21	144	1	−5	1[c]	0	77	1	77
DR	21	144	1	−5	0	0	...	2	77
51-9	21	138	0	...	0	9/60[c]	86	3	77
51-9C	21	131	0	...	0	9/60[d]	54	3	77
17-3C	21	130	0	...	0	3/20[d]	54	3	77

[a] Where the exposure cycles are designated by sequence figures, the first figure refers to the number of minutes of light alone and the second to the number of minutes of light and water spray. Where cycles are designated by letters, the order of the letters indicates the order of application of light (D), refrigeration (R), and water spray (W).

[b] The maximum temperatures were those read on a mercury thermometer, the bulb of which was covered with a 0.025-in. coating of asphalt and mounted centrally on the face of an auxiliary test specimen.

[c] Mist-type water spray—½ gpm of water at 20 to 25 psi and 77 ± 3 F.

[d] Fish-tail-type water spray—1½ gpm of water at 20 to 25 psi and 40 ± 2 F.

During exposure, the specimens were mounted by means of stainless-steel clips on auxiliary aluminum supports, two to a support, one above the other. These supports fitted snugly into the regular panel-holding slots in the drums.

On alternate days the specimens and the supports were inverted to offset the effect of the vertical gradients of heat and light. Every seven days the specimens were inspected by means of a high-voltage probe.[10] These inspections were made after not less than 10 min of exposure to light alone. Those containing breaks in the coating were spark-photographed.[11]

Evaluation of the coatings was made from the spark photographs by means of a 2 by 5-in. grid of 60 equal rectangles. (Approximately 1/8 in. along the edges of the coating was excluded.) The time in days to the first break in the coating was designated "initial failure." When breaks were recorded in 30 or more of the 60 areas in the coating, the specimen attained final failure.

TABLE III.—TIME TO INITIAL AND FINAL FAILURES.

Exposure Cycle[a]	Asphalt I		Asphalt II		Asphalt III	
	Initial Failure, days	Final Failure, days	Initial Failure, days	Final Failure, days	Initial Failure, days	Final Failure, days
DW	108[b]	116[c]	214[b]	230[c]	81[b]	130[c]
	66[b]	116[c]	214[b]	224[c]	81[b]	123[c]
DRW	42	42	51	56	43	51
	42	42	51	56	43	43
DR	23	44	39	44	23	44
	38	44	...	...	...	...
51-9	47	61	83	105	70	92
	54	61	83	105	70	72
51-9C	40	40	46	66	42	47
	40	40	59	66	47	66
17-3C	41	48	48	62	70	70
	41	48	55	69	56	70

[a] See Table II for descriptions of cycles.
[b] Initial failure: first cracks recorded on spark photograph.
[c] Final failure: cracks recorded on spark photograph distributed over at least 50 per cent of the coating area.

Results

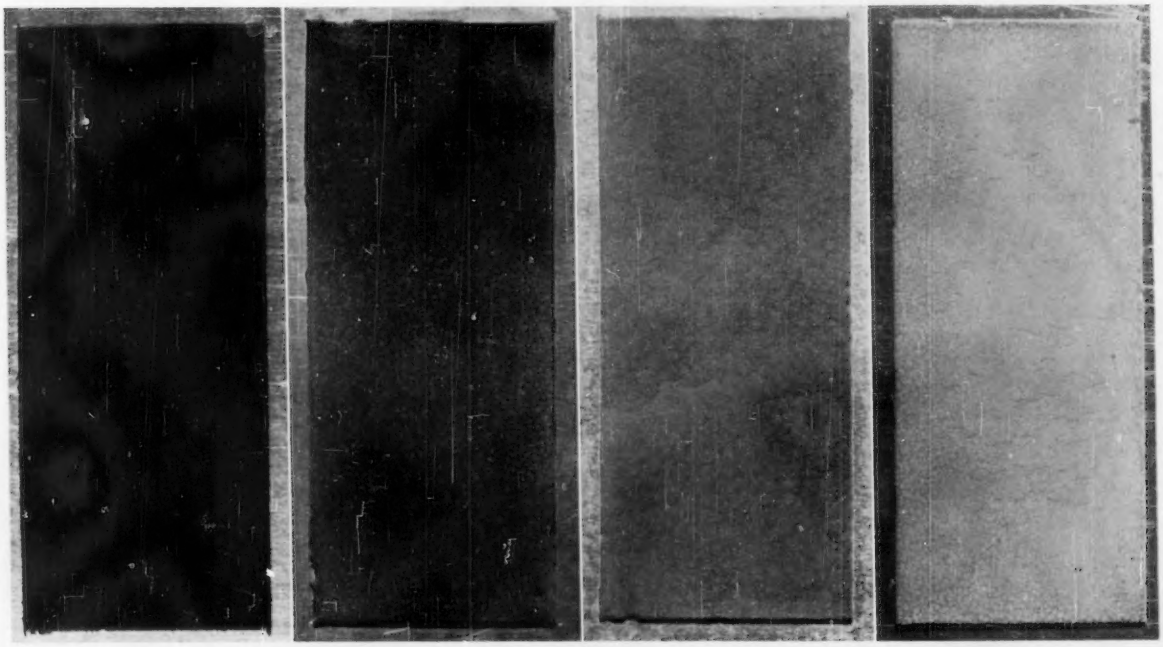
In Table III are presented the data on the repeatability of the times to initial and final failure of duplicate specimens of the three asphalts under the six conditions of test, and Fig. 1 is a graphical presentation of the durability of the three asphalts exposed to the six cycles. Figure 2 illustrates the appearance of asphalt I at 29 days, while Fig. 3 shows the effects of salt deposits from spray water. Figure 4 is a comparison of specimens of asphalt I at final failure.

Discussion of Results

Several of the recognized shortcomings of methods for evaluating asphalts by means of the extent of cracking were avoided in this investigation. All of the test specimens were made by the

[10] A. H. Boenau and L. H. Baum, "The Design and Application of a Spark-Gap Instrument for Detecting Crack Failures of Asphalt Coatings During Weathering Tests," Symposium on Accelerated Durability Testing of Bituminous Materials, p. 153, Am. Soc. Testing Mats. (1949). (Issued as separate publication, ASTM *STP No. 94*.)

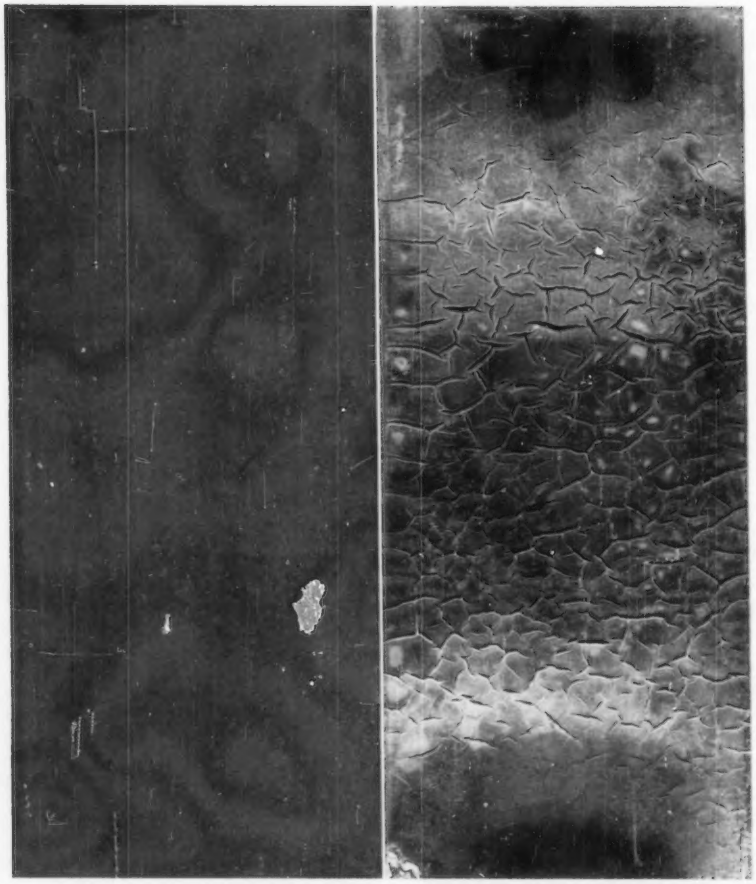
[11] J. B. Hunter, G. C. Gzemski, and L. Laskaris, "A New Method for Evaluating Failure of Bituminous Materials Due to Weathering," Symposium on Accelerated Durability Testing of Bituminous Materials, p. 144, Am. Soc. Testing Mats. (1949). (Issued as separate publication, ASTM *STP No. 94*.)



DRW 51-9 51-9C 17-3C

Fig. 2.—Asphalt I After 29 Days of Exposure to Four Different Cycles.

The light-colored coating is not evident on the most thoroughly washed panel.



Panel *A* Panel *B*

Fig. 3.—The Effect Produced by Salts Dissolved in the Spray Water.

Panel *A* has been washed with demineralized water while panel *B* has been washed with tap water. The white deposits at both the top and bottom of panel *B* are salts precipitated as the water evaporated.

same operators. They were exposed concurrently in four machines in the same room (exposures to cycles DR, DRW, and DW were made in the same machine). The ambient temperature of the room was controlled within ±3 F. All units were operated from the same 208-v feeder, where daily fluctuations were no greater than ±2 v. All machines were operated 7 days a week, 21 hr a day. The down time for inspection and maintenance occurred at the same time each day. The temperatures of the spray waters were closely controlled either by storage in the accelerated durability room or by passage through a thermoregulated continuous cooler.

Despite the careful control of the exposure conditions, duplicate specimens exposed side by side in the same machine were found to have different durabilities. The data reported in Table III indicate that the differences in times to final failure of duplicate specimens were influenced as much by the characteristics of the individual asphalts as by the exposure conditions. The times to final failure for the duplicate specimens of asphalt I were the same for all exposure conditions. The greatest differences between the times to final failure of duplicate specimens were found in asphalt III. For cycles 51-9 51-9C, DRW, and DW, differences of 20, 19, 8, and 7 days, respectively, were recorded.

In Fig. 1, the average durability is plotted against the exposure cycles, arranged in the order of intensity of thermal shock. The DW cycle, with little, or possibly no, thermal shock, showed the greatest differences among the asphalts. However, the exposures were so prolonged that this cycle is impractical for accelerated test purposes. The introduction of a mild thermal shock, by the use of 77 F spray water during the light period, decreased the times to final failure, but also decreased the spread among the asphalts. When the intensity of the thermal shock was increased by the use of 40 ± 2 F spray water, its effect was again a decrease in times to final failure and a decrease in the spread among the asphalts.

The replacement of the frequent thermal shocks of the 51-9C cycle with the more severe single shock of the DRW cycle did not appreciably shorten the durabilities of the asphalts, but did compress the spread in durability. The extra handling involved in transferring the specimens to and from the freezer was a further disadvantage of the DRW cycle.

When the wash period was eliminated, as in the DR cycle, the one thermal shock a day was sufficient to produce final failures in all three asphalts rapidly and simultaneously. Thus, the wash period seemed to be essential to the relieving of the many strains set up in the degrading asphalt film.

The importance of the wash periods is illustrated in Figs. 2 and 4. Figure 2 illustrates the appearance of the specimens of asphalt I after 29 days of exposure to cycles DRW, 51-9, 51-9C, and 17-3C. In Fig. 4 are the specimens prepared from the same asphalts at final failure. The formation of water-soluble products from asphalt has been reported by several investigators.[12,13] The light-colored deposits on the specimens in Fig. 2, were due to incomplete removal or redeposition of the water-soluble degradation products. The extent of these deposits had a direct relationship to the thoroughness of the washing periods. Little or no deposition occurred on the specimens exposed to cycle DRW, whereas the greatest deposit was found on those exposed to the 17-3C cycle. The higher-temperature (77 ± 3 F) spray water of cycle 51-9 apparently was more effective in preventing this deposit than the cooler (40 ± 2 F) water in the 51-9C. This type of deposit should not be confused with that resulting from the deposition of mineral salts from some tap waters. Such deposits occur mainly at the ends of the test specimens as illustrated in Fig. 3.

A qualitative relationship between crack configuration and the thoroughness of washing is shown in Fig. 4.

[12] O. G. Strieter and H. R. Snoke, "A Modified Accelerated Test for Asphalt and Other Materials," *Journal of Research*. Nat. Bureau Standards, Vol. 16, No. 5, May, 1936, pp. 481–487 (*RP* 886).

[13] W. F. Fair, Jr., H. R. Beck, and B. K. McKee, "Accelerated Weathering of Pitches and Asphalts," Symposium on Accelerated Durability Testing of Bituminous Materials, p. 109, Am. Soc. Testing Mats. (1949). (Issued as separate publication *ASTM STP No. 94*.)

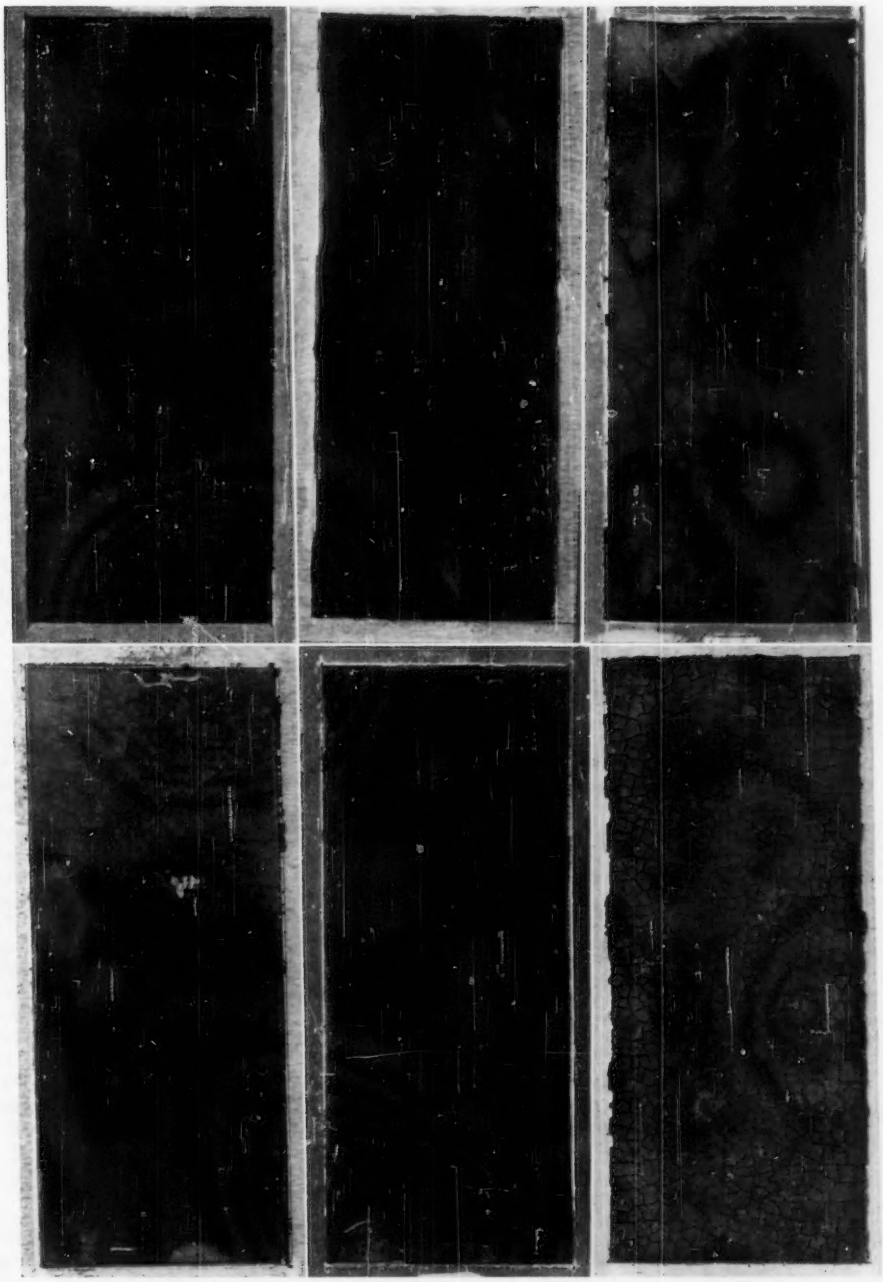


Fig. 4.—Variation of Type of Cracking with Removal of Weathering Products on Representative Panels from Six Different Exposure Cycles.

There are long, fine vertical cracks in the coatings, subjected to cycles DW and DRW that are not apparent in this photograph.

Cracking parallel to the long axis of the coatings was prevalent on specimens exposed to both the DW and DRW cycles. (These cracks are so fine that they do not show on the photograph.) No marked differences were noted in the crack configurations for the two exposures. As the thoroughness of the washing decreased, the cracking became more random in nature and interlocking. This was most pronounced for exposures made to the DR cycle. (The DR cycle should not be considered strictly a dry cycle, for considerable condensate collected on the specimens on their removal from the cold box. This was allowed to evaporate or to be absorbed by the coating before it was replaced in the test unit.)

Conclusions

A cycle selected for the evaluation of asphalts may range from one of extreme acceleration of crack failure with no differentiation among asphalts (DR) to one of great differentiation with much less acceleration (DW). Of the cycles investigated, the one that seemed to produce the most satisfactory compromise between these extremes was the 51-9C cycle. However, in every cycle that included a spray period, within the precision of the data, the asphalts failed in the same relative order.

A Small and Inexpensive Device for Sustained Loading Testing

By R. H. Raring and J. A. Rinebolt

ONE OF THE most serious impediments to the use of constructional steels at strength levels in the range of 200,000 to 300,000 psi is the danger of sustained loading failure. These are brittle failures that occur when static stresses are sustained for long periods of time. There have been many instances of such fractures of service parts (**1**)[1] and laboratory tests (**2**) have shown that they result from cracks that enlarge slowly under the influence of static stress. It is clear that static fracture in steel is a phenomenon that must be understood and brought under control before constructional steels at strength levels above 200,000 psi can be used with confidence.

The determination of the effects of metallurgical variables on the susceptibility to static failure creates a demand on test facilities that few laboratories can satisfy. Obviously, the use of universal testing machines is impractical because of the extended time each specimen is under test and the large number of specimens that must be used. The purpose of the article is to describe a small, easily made, tensile loading device that has provided a cheap, fast, and satisfactory method of making sustained loading tests.

With proper calibration and measurement instruments, an accuracy of ±1 per cent can be obtained.

Description

Figure 1 is a photograph of the testing device with a specimen in the test position. It is patterned after the well-known elastic proving rings (**3,4**) used for calibration of universal testing machines.

The ring is machined from SAE 52100 tubing, which is readily available from warehouse stock, oil quenched and tempered to a hardness of about Rockwell C 43. The specimen and specimen holders are aligned on an accurately determined diameter. Contact between the loading bolts and the outside of the ring is made through mild-steel bolsters to provide a uniform distribution of the load. The large bottom nut, Fig. 1, is cut with a micrometer thread; it is about 1½-in. long to provide thread strength. The specimen is loaded by tightening the bottom nut until the diameter of the ring corresponds to the desired load as obtained from the load *versus* diameter calibration curve for the ring.

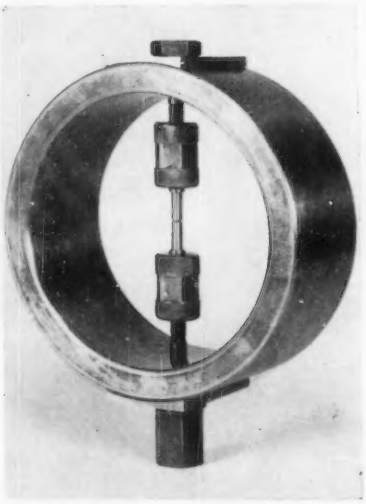


Fig. 1.—Elastic Ring for Sustained Loading Testing.

In order to prevent the introduction of torque into the specimen during loading, the ring is secured to a surface plate to which are fastened shackles that restrain the grips, as shown in Fig. 2. A long-handle wrench, also shown in Fig. 2, is used to tighten the loading nut.

While under load, considerable elastic energy is stored in the ring. The sudden release of energy when failure occurs displaces the tightening nut, and the motion therefrom activates the mechanism (Fig. 3) causing the microswitch to open. The microswitch controls an electric timer that records the time required to fracture the specimen.

Calibration

Each ring is calibrated by applying compression loads on the loading assembly by means of a universal testing machine, and measuring the corresponding inside diameter. This is representative of the conditions that obtain in use, for in both situations the bolt head and the micrometer nut exert compressive loads between the bolsters and the ring.

The accuracy and precision of the ring calibration will depend upon the accuracy of the testing machine and precision of the measurement of the ring diameter. Universal testing machines are usually well within the ±1 per cent tolerance required by ASTM standards, and the diameter of the ring can be measured to 0.001 in. and estimated to 0.0001 in. with an ordinary inside micrometer. Higher precision of diameter measurement could be obtained by the methods used for reading proving rings (**4**), but the increased mechanical complication would not be justified for

RICHARD H. RARING, National Advisory Committee for Aeronautics, Washington, D. C., has been in metallurgical engineering production and research since 1936. At the time the work described in this paper was performed, he was with the Naval Research Laboratory.

J. A. RINEBOLT, Metallurgist, Research and Development Dept., Republic Steel Corp., Canton Ohio, was for 12 years with the Naval Research Laboratory where the work described in this paper was done.

[1] The boldface numbers in parentheses refer to the list of references appended to this paper.

this application. For example, rings used at the Naval Research Laboratory in the load range 5000 to 10,000 lb have a deflection of 0.001 in. for about 75 lb. Assuming that the micrometer can be read to within 0.0002 in., which is considered to be conservative, the corresponding precision of load determination would be about ±0.3 per cent at 5000 lb. Since this is about the order of accuracy of the universal testing machine used for the calibration of the ring, it would be vain to measure the ring diameter with greater precision.

The calibration factor, that is the number of pounds required to deflect the ring 0.001 in., has been found to be essentially constant at deflections of 0.150 in. and less. It is possible that if a more accurate load standard were used for calibration and if a more precise method of measuring the ring diameter were employed, a variation in the calibration factor would be observed, just as in the case of proving ring calibration (**4**). Calibration factors of proving rings can vary by ½ to 1 per cent over their load range (**4**); however it is considered that the calibration factor of the testing rings should be more nearly constant because the asymmetry introduced by the integral bosses of proving rings is absent in the testing rings.

Since the dimensions of the ring, the elastic properties of the steel, and the length of the inside micrometer are sensitive to temperature change, it is highly desirable to conduct the test at the same temperature at which the calibration was made. Calibration constants can change by about 0.02 per cent per deg Fahr (**4**), and corrections can be made in the calibration by formulas given in reference **4**. The most satisfactory solution, however, is to calibrate and use the rings in a constant-temperature room.

Ring Design

The optimum dimensions of the test ring will depend on the load at which it is to be used. At capacity load, a deflection of about 0.10 in. to 0.15 in. has been found to be satisfactory, and the dimensions of a ring with this approximate deflection can be estimated from the formula (**5**):

$$\delta = 0.149\frac{PR^3}{EI}$$

where:

δ = change in diameter, in.,
P = load, lb,
R = radius of center line, in.,
I = moment of inertia of cross-section, and
E = Young's modulus, psi.

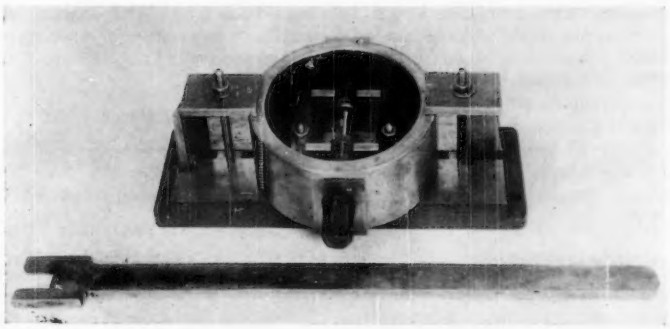


Fig. 2.—Auxiliary Gear for Loading Ring.

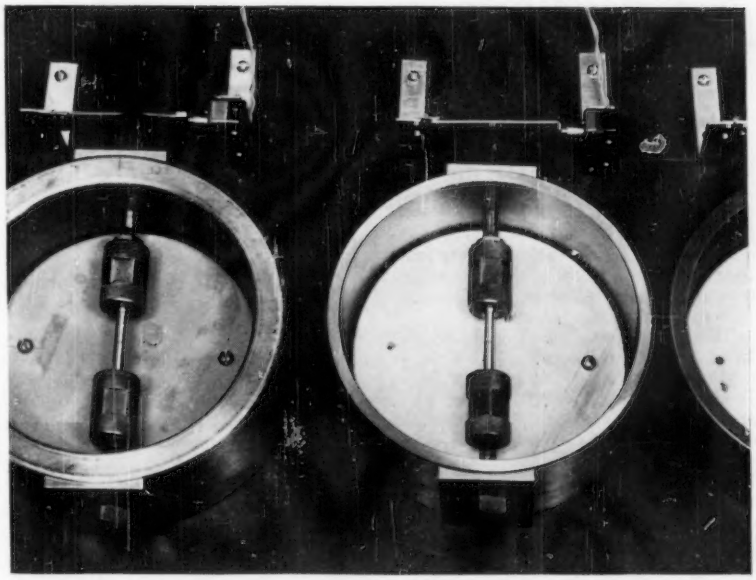


Fig. 3.—Rings in Test Station Showing Timing Apparatus

This formula assumes a perfect ring, and since the testing rings contain imperfections in the form of holes to receive the specimen holder, the formula is only approximate.

For example, a typical ring with inside diameter of 6.37 in. and outside diameter of 7.12 in. and width of 3 in., for use in the range of 5000 to 10,000 lb, had an actual calibration factor of 73.6 lb per 0.001-in. deflection. The calculated calibration factor was 69 lb per 0.001 in.

Stability

Rings which have been in use for about 3000 hr at loads from one-third to full capacity have shown no significant changes in either the no-load reading or in the calibration constants. It has been considered prudent to spot-check the calibration constants of new rings during the first few 100 hr of use, but in no instance has it been necessary to correct the constant. The no-load dimensions, of course, are rechecked each time the ring is used.

It is obvious that if any creep or relaxation in the specimen or specimen holder occurs, the load exerted by the ring would change with time. No difficulties of this sort were encountered when testing specimens of quenched and tempered AISI 4340 steel at room temperature or stresses as high as 75 per cent of the breaking strength for times in excess of one month. It is considered that under such conditions of test the amount of creep, if any occurs at all, has a negligible effect on the load.

A small and simple device for applying and maintaining load on a tension specimen for static fatigue testing of steel is described. It is based on the principle of the elastic proving ring. Accuracy depends on the quality of

the standards used for calibration, and the instruments used for measurement of the ring diameter; if an ordinary universal testing machine and standards inside micrometer are used, it is estimated that an accuracy of the order of ±1 per cent can be realized. A battery of these machines is in use at the Naval Research Laboratory with entirely satisfactory results.

Acknowledgment:

The help of George Gregg, who designed and calibrated the rings and conceived, designed, and constructed the auxiliary apparatus for loading, measuring, and timing is gratefully acknowledged.

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(2) R. H. Raring, and J. A. Rinebolt, "Static Fatigue of High-Strength Steel," to be published in *Transactions,* ASM. Preprint no. 31, 1955.

(3) H. L. Whittemore and S. N. Petrenko, Proving Ring, U. S. Patent Nos. 1648375 and 1927478, Nov 8, 1927 and Sept 19, 1933, respectively.

(4) B. L. Wilson, D. R. Tate, and G. Borkowski, "Proving Rings for Calibrating Testing Machines," National Bureau of Standards *Circular No. C454,* August 14, 1946.

(5) S. Timoshenko, and J. M. Lessells, "Applied Elasticity," Constable and Co., Ltd., London, (1928).

The Bookshelf

Tables of Spectrum Lines

A. N. Zaidel, V. K. Prokof'ev and S. M. Raiskii; International Ed (1955) (Foreword and explanatory text in German, English, and French), VEB Verlag Technik, Berlin; Price: 29 DM.

THESE tables are the first ever designed specifically for use in spectrochemistry. The original Russian edition was published in 1952.

The tables consist of three main sections. Section I is a list of 40,000 lines selected from the 109,000 in G. R. Harrison's MIT Wavelength Tables, and arranged by wavelength. The spectra of 37 of the most common metals and metalloids are given in full, along with the principal "air" lines; certain minor lines of the less common lines have been omitted. The shortening was effected principally by entirely omitting the spectra of the halogens (except I), rare earths (except Ce), trans-uranics, noble gases, Pa, Po, Ra, Rn, Th and U.

In Section II, 23,000 lines of 93 elements are arranged by element. Excitation potentials are given for 75 per cent of the lines in this section. These values were obtained from Charlotte E. Moore's 1945 "A Multiplet Table of Astrophysical Interest" and original sources.

Section III contains tables of (1) ionization potentials of atoms and ions; (2) melting and boiling points of elements and oxides; (3) A. K. Rusanov's tables of elements in order of their appearance in the d-c arc; (4) sensitive lines by element and wavelength; (5) the spectrum of molecular H_2; and (6) the spectrum of atomic deuterium.

The shortening of Section I was performed in a most intelligent and almost painless manner, and should not impair its usefulness for most spectrochemical laboratories. The spectrochemist has long wished for tables in which excitation potentials were listed in order of wavelength under each element. Although these potentials were available previously, much of the information was not readily accessible or conveniently arranged. The tables in Section II should do much to encourage the use of excitation potentials in selecting internal standard lines. The tables in Section III are of obvious usefulness; in several cases they indicate growing attention to physical and chemical processes occurring in the arc.

This book will be a very valuable addition to the working library of the spectrochemist.

CYRUS FELDMAN

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OTS Research Reports

Office of Technical Services, Department of Commerce, Washington 25, D. C.

Optical and Photoconductive Properties of Silicon and Germanium

DIVIDED into a discussion of properties intrinsic to the elemental semiconductor and of those properties that are due to impurities in the lattice. The addition of impurities in these semiconductors is shown to have an important effect on electrical and optical properties. Correlations between energy levels set up by impurities and their distribution coefficients and diffusion constants are indicated. Optical absorption, photoresponse, and impact ionization of these centers are presented in terms of a hydrogen model, and deviations from the model are noted. A simple treatment for impurity photoconductivity is given, and magnitude of response is calculated for various conditions of doping, background radiation, and competitive absorption. Practical considerations relating to the effective use of these photoconductors are included. 46 pp., *PB 111748;* $1.25.

Effects of Radiation on Dielectric Materials

Representatives of Government, industry, and university laboratories participated in a Naval Research Laboratory Conference on the effects of radiation on dielectric materials. The conferees also discussed the general aspects of the wide variety of disciplines in the field.

Many of the papers deal with radiation effects on specific dielectric materials. Included in the book are such subjects as radiation stability of polymers, concepts of radiation chemistry, a survey of the chemistry of polymer formation, effects on glass, conductivity of polyethylene and teflon during irradiation, and an evaluation of the effects of radiation on organic materials. *PB 111863,* 171 pp; $4.25.

Research on Boron Polymers, Part II, Polymer Studies.

Covers 18 months of research during which exploratory study was made of certain boron compounds and polymers in connection with the development of plastics and elastomers which are thermally stable and are oil and fuel resistant. This project was directed toward the synthesis of quadricovalent chelate and quasi-chelate boronic acids and borates. The diethanolamine ester of benzene-boronic acid was prepared which was stable to hydrolysis and could be recrystallized from water. Allylboronic acid and its esters were synthesized and studied. *PB 111892;* 85 pp., $2.25.

Research on the Preparation and Properties of High-Temperature-Resistant Copolymers.

The reaction between para-dichlorobenzene and alkali metals in the presence of various unsaturated compounds is investigated to determine whether heat-resistant copolymers could thus be prepared. Among the unsaturated compounds used are vinyl acetate, ethylene, isobutylene, methyl acrylate, acrylonitrils, and butadiene-1,3. From each of these reactions polymeric material melting above 250 C was obtained. From a consideration of the method of preparation and properties of these materials, it is concluded that they are copolymers whose molecules contain rigid segments of phenylene units interspersed with segments consisting of flexible carbon-carbon chains. In these copolymers the properties of polyphenyl, an infusible material are modified by those of the vinyl polymers. *PB 111765;* 23 pp.; 75 cents.

(*Continued on page 84*)

An Improved Sulfate Soundness Test for Aggregates

By D. O. Woolf

Subcommittee III-e on Methods of Testing Concrete Aggregates for Physical Characteristics of ASTM Committee C-9 on Concrete and Concrete Aggregates invites comments with respect to these recommendations concerning desirable changes in the sulfate soundness test.

The present sulfate soundness test method, AASHO Method T 104–46 or ASTM Method C 88 – 46 T,[1] permits in tests of coarse aggregate the determination of six different values any one of which may be considered as "standard." Different laboratories may not agree on the method to be used in testing a given sample of aggregate. An unwarranted dependence is placed on the results of the test. To correct these, it is recommended that the method be used for the acceptance but not the rejection of aggregates, that the sample tested be restricted to one size of coarse or fine aggregate, that the drying oven meet requirements for performance, that the loss for coarse aggregate be determined with sieves having openings one-half the size of those in the original retaining sieves, and that certain minor changes be made. It is believed that these changes will result in better agreement among laboratories conducting check tests, and that the test result will permit a reliable appraisal of the soundness of the material under test.

ONE OF THE first descriptions in American roadbuilding literature of the sodium sulfate soundness test for aggregate appeared in *Bulletin 1216* of the U. S. Department of Agriculture. In this bulletin, the tentative methods of sampling and testing highway materials were described as adopted in 1922 by the American Association of State Highway Officials. The description of the soundness test is remarkable due to its brevity and clearness. It read: "Immerse 10 small pieces (total weight about 1000 g.) of the rock in a saturated solution at 70 F of sodium sulfate (Na_2SO_4) for 20 hr, after which place them for 4 hr in a drying oven maintained at 100 C (212 F). Repeat the treatment five times. Note the condition of the rock as to soundness at the end of the test. Samples which exhibit marked checking, cracking, or disintegration shall be considered to have failed in this test."

With this publication, a long program of study of the sodium sulfate soundness test began. Change after change was made in the method with a view toward broadening it to cover both fine and coarse aggregate, and to standardize it in all its details. In addition, some users saw in the method a chance to develop an acceptance test of aggregate which could be made in a relatively short time in comparison with that required for a freezing-and-thawing test. With little regard to the actual processes involved in the crystallization of sulfate salts or of the proper interpretation of the test results, the use of the test for the acceptance or rejection of aggregates was solemnly endorsed. Under pressure for a quick decision, the highway testing engineer turned to the sulfate soundness test as a measure of the acceptability of aggregates. With further misunderstanding of the applicability of the method, requirements for the loss in the sulfate soundness test were written in specifications for aggregates. The use of the method and of requirements based thereon were widely adopted by construction authorities.

Laboratories found difficulty in obtaining reproducible test results or in testing materials in strict accordance with the requirements of the method. An attempt to adjust the method to permit the testing of aggregates of various gradations was made.

The first mention of the testing of graded coarse aggregate appeared in the ASTM Method C 89 – 31 T.[2] This method required that the aggregate be separated and tested in the following sizes:

Size	Minimum Weight of Sample, g
No. 4 (0.185 in.) to ⅜ in.	100
⅜ in. to ¾ in.	300
¾ in. to 1½ in.	1500
1½ in. to 2½ in.	3000
Larger sizes by 1-in. spread	3000

The reason for the selection of these sizes is not known, but it appears that the use of the so-called fineness modulus sieves was considered desirable. However, the largest size does not include the 3-in. sieve as used in the fineness modulus series of sieves. It is possible that a difference of 1-in. between the sizes of the two sieves used to prepare the test sample was as great as was deemed advisable.

Difficulties in obtaining check results of soundness tests between laboratories or even in the same laboratory were the general rule. Possibly in an attempt to correct this, the grading of the sample was more closely defined in AASHO Method T 104 – 42 and ASTM Method C 88 – 41 T. In these revised methods, the same sizes of coarse aggregate as shown in the 1931 ASTM method were used, but each of the three sizes between the ¾-in. and 2½-in. sieves was separated into a coarse and a fine frac-

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[1] "Tentative Method of Test for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate," 1955 Book of ASTM Standards, Part 3, p. 1225.

[2] "Tentative Method of Test for Soundness of Coarse Aggregates by Use of Sodium Sulfate" (C 89 – 31 T), *Proceedings*, Am. Soc. Testing Mats., Vol. 31, Part I, p. 773 (1931). Methods C 88 for fine aggregate and C 89 for coarse aggregate were combined in 1937 and identified as C 88 (1955 Book of ASTM Standards, Part 3, p. 1225). AASHO methods T 75 and T 76 for the sulfate soundness test of fine and coarse aggregates, respectively, were combined in 1938 and identified as T 104.

tion and these fractions recombined in a prescribed ratio. Some of the minimum weights for sizes tested were also increased. The requirements for the composition of the sample tested were as follows:

GRADING 1

Size	Minimum Weight of Sample, g
No. 4 to ⅜ in.	300
⅜ in. to ¾ in.	1000
Consisting of 33 per cent ⅜ in. to ½ in.	
67 per cent ½ in. to ¾ in.	
¾ in. to 1½ in.	1500
Consisting of 33 per cent ¾ in. to 1 in.	
67 per cent 1 in. to 1½ in.	
1½ in. to 2½ in.	3000
Consisting of 50 per cent 1½ in. to 2 in.	
50 per cent 2 in. to 2½ in.	
Larger sizes by 1-in. spread in sieve size, each fraction	3000

The sizings established in this revision did not prove satisfactory. Many aggregates for concrete did not contain material larger than 2 in., but did contain enough of the 1½-in. to 2-in. size to require that this size be tested. Considerable confusion developed regarding the sample to be prepared for test. Some laboratories ignored the requirement that the sample contain some 2-in. to 2½-in. material. Since it was not present in the aggregate as submitted, it could not be tested. These laboratories then tested the 1½-in. to 2-in. size. Other laboratories adhered more closely to the requirements of the method and did not test the 1½-in. to 2-in. size if there was no aggregate larger than 2 in. The results of check tests between laboratories were not in good agreement, and the method was repeatedly condemned as unsatisfactory.

Use of Alternate Gradings

To alleviate some of the troubles found, a second grading for the preparation of the sample was added to the method in 1946 by both the AASHO and the ASTM. This grading, described as alternate A, required the following combination of sizes:

ALTERNATE A

Size	Minimum Weight of Sample, g
No. 4 to ½ in.	300
½ in. to 1 in.	1500
Consisting of 33 per cent ½ in. to ¾ in.	
67 per cent ¾ in. to 1 in.	
1 in. to 2 in.	3000
Consisting of 50 per cent 1 in. to 1½ in.	
50 per cent 1½ in. to 2 in.	
Larger sizes by 1-in. spread in sieve size, each fraction	3000

At the same time, a third grading was adopted, possibly to satisfy criticism of the use of the two other combinations of sizes. This grading was identified as alternate B, and required use of the following sizes and weights of sample:

ALTERNATE B

Size	Minimum Weight of Sample, g
No. 4 to ⅝ in.	300
⅝ in. to ½ in.	500
½ in. to ¾ in.	750
¾ in. to 1 in.	1000
1 in. to 1½ in.	1500
1½ in. to 2 in.	2000
Larger sizes by 1-in. spread in sieve size, each fraction	3000

All three of the gradings for the test sample are now equally standardized with respect to this method of test, and confusion may develop if one is designated here as the "standard." As two of the gradings are now described as alternates A and B, the other which was the first grading adopted is identified here as "grading 1."

Determination of Loss

Provision for the determination of the loss by either of two methods will be found in the 1941 and subsequent revisions of the sulfate soundness test. The loss may be the material passing the sieve on which the sample was originally retained, or the material passing a sieve having openings one-half of that size. The initial retaining sieve considered here is that for the combination of sizes of fragment which are tested together. In grading 1, for example, the original retaining sieve for the ¾-in. to 1-in., and the 1-in. to 1½-in. sizes, would be the ¾-in. sieve, and the half size sieve would be the ⅜-in. sieve.

The use of the half-size sieve to determine the loss in the test has three excellent features: It should permit a nominal variation between sieves used in different laboratories to prepare the test sample, and will not require an excessively meticulous separation by size and minute attention to particles of flat or elongated shape. Secondly, it should prevent the accidental inclusion in the loss of pieces which are structurally sound, but due to handling during the test, may suffer minor flaking or chipping of corners and edges and which may pass the initial retaining sieve and be included, quite incorrectly, in the loss. Finally, the material passing this half-size sieve would be material which had suffered multiple cracking or disintegration. It would be material which actually was unsound, instead of material which had suffered minor surface damage or had broken along incipient fractures developed in the crushing and handling of the aggregate at the plant.

Variation in Loss Due to Testing Procedure

The method of test for coarse aggregate as now written permits the use of three different gradings and the determination of the loss by either of two methods. If a sample of a certain but not unusual size is tested, there may be some doubt, as previously mentioned, in the sizes to be tested. An aggregate of 2-in. to No. 4 size, containing 5 per cent or more of the 2-in. to 1½-in. size, would be included in this category. If it is desired to obtain the maximum information of the quality of the sample,

TABLE I.—REQUIREMENTS FOR SAMPLE OF 2-IN. TO NO. 4 AGGREGATE PREPARED FOR SULFATE SOUNDNESS TEST (AASHO METHOD T 104 - 46).

Size of Fragment, in.	Grouping of Sizes for Test, Minimum Weight of Sample, and Sieve Used to Determine Loss					
	Grading 1		Alternate A		Alternate B	
	Minimum Weight, g	Sieve Used for Loss, in.[a]	Minimum Weight, g	Sieve Used for Loss, in.[a]	Minimum Weight, g	Sieve Used for Loss, in.[a]
2–1½	3000	1½	1500	1	2000	1½
1½–1	1000	¾	1500		1500	1
1–¾	500		1000	½	1000	¾
¾–½	670	⅜	500		750	½
½–⅜	330		300[b]	No. 4	500	⅜
⅜–No. 4	300	No. 4			300	No. 4
Total min. wt.	5800		4800		6050	

[a] A sieve having an opening one-half of the size given may be used as an alternate.
[b] Applies to ½-in. to No. 4 aggregate; no requirements given for sizes separated by the ⅜-in. sieve.

TABLE II.—GRADING OF SAMPLE AND LOSS IN SULFATE SOUNDNESS TEST.

Size Tested, in.	Grading as Received, per cent	Passing Sieve After Test,[a] per cent							
		1½ in.	1 in.	¾ in.	½ in.	⅜ in.	No. 3	No. 4	No. 8
2–1½	5	19.4	10.6	4.8	2.3	...	...	...	...
1½–1	21	...	11.8	11.2	10.9	9.5	...	...	...
1–¾	19	...	...	17.2	12.0	8.1	5.0	...	...
¾–½	17	...	...	...	18.1	13.1	8.9	5.4	...
½–⅜	16	...	...	...	...	17.0	11.8	8.8	6.8
⅜–No. 5	22	...	...	...	...	...	...	11.3	7.0

[a] Percentage of fraction originally retained on each sieve.

TABLE III.—COMPUTATIONS OF TEST RESULTS FOR SAMPLE TESTED WITH ALTERNATE B GRADING.

Size Tested, in.	Actual Loss, per cent	Grading as Received, per cent	Weighted Average Loss, per cent
Loss Determined Using Full-Size Sieves			
2–1½	19.4	5	0.97
1½–1	11.8	21	2.48
1–¾	17.2	19	3.27
¾–½	18.1	17	3.08
½–⅜	17.0	16	2.72
⅜–No. 4	11.3	22	2.48
Totals		100	15.0
Loss Determined Using Half-Size Sieves			
2–1½	4.8	5	0.24
1½–1	10.9	21	2.29
1–¾	8.1	19	1.54
¾–½	8.9	17	1.51
½–⅜	8.8	16	1.41
⅜–No. 4	7.0	22	1.54
Totals		100	8.5

TABLE IV.—COMPUTATION OF TEST RESULTS FOR SAMPLE TESTED WITH GRADING 1.

Size Tested, in.	Actual Loss, per cent	Conversion Factor	Converted Values for Loss, per cent	Loss for Specified Combinations of Sizes, per cent	Grading as Received, per cent	Weighted Average Loss, per cent
Loss Determined Using Full-Size Sieves						
2–1½	19.4	1.00	19.4	19.4	5	0.97
1½–1	11.2	0.67	7.5	13.2	40	5.28
1–¾	17.2	0.33	5.7			
¾–½	13.1	0.67	8.8	14.4	33	4.75
½–⅜	17.0	0.33	5.6			
⅜–No. 4	11.3	1.00	11.3	11.3	22	2.49
Totals					100	13.5
Loss Determined Using Half-Size Sieves						
2–1½	4.8	1.00	4.8	4.8	5	0.24
1½–1	9.5	0.67	6.4	9.1	40	3.64
1–¾	8.1	0.33	2.7			
¾–½	5.4	0.67	3.6	6.5	33	2.14
½–⅜	8.8	0.33	2.9			
⅜–No. 4	7.0	1.00	7.0	7.0	22	1.54
Totals					100	7.6

TABLE V.—COMPUTATIONS OF TEST RESULTS FOR SAMPLE TESTED WITH ALTERNATE A GRADING.

Size Tested, in.	Actual Loss, per cent	Conversion Factor	Converted Values for Loss, per cent	Loss for Specified Combinations of Sizes, per cent	Grading as Received, per cent	Weighted Average Loss, per cent
Loss Determined Using Full-Size Sieves						
2–1½	10.6	0.50	5.3	11.2	26	2.91
1½–1	11.8	0.50	5.9			
1–¾	12.0	0.67	8.0	14.0	36	5.04
¾–½	18.1	0.33	6.0			
½–⅜	8.8	0.42[a]	3.7	10.2	38	3.87
⅜–No. 4	11.3	0.58[a]	6.5			
Totals					100	11.8
Loss Determined Using Half-Size Sieves						
2–1½	2.3	0.50	1.2	6.6	26	1.72
1½–1	10.9	0.50	5.4			
1–¾	5.0	0.67	3.4	6.3	36	2.27
¾–½	8.9	0.33	2.9			
½–⅜	6.8	0.42[a]	2.9	7.0	38	2.66
⅜–No. 4	7.0	0.58[a]	4.1			
Totals					100	6.7

[a] Relative amounts of these sizes to be used are not shown in the method of test. Conversion factors used are based on amount of each size in material as received.

many laboratories may prepare the test material in accordance with grading 1, using presumably a 3000 – g sample of 2-in. to 1½-in. aggregate. A summary of the test samples which might be prepared with this material is given in Table I.

It is quite unusual for different sizes of a sample of aggregate to have the same or nearly the same loss in the sulfate soundness test. Consequently samples of one aggregate prepared with the three different gradings may have markedly different losses. The loss as determined with the half-size sieve is only in rare cases of the same order of magnitude as that found with the original retaining sieve. Acceptance or rejection of an aggregate may then be governed by the grading used in the test and the method of determining the loss.

An illustration of this is presented in Tables II, III, IV, and V. The values given in Table II were obtained in a routine test of a sample of gravel. The grading of the sample as received conforms to AASHO Specification M 80 – 49 for coarse aggregate. This grading is such that the sample tested may be prepared to have either of the combinations of sizes described here as grading 1 and alternate A, or the sample may be tested by the individual size method identified as alternate B.

The sample was tested by the individual size method (alternate B) to obtain the most information regarding its quality. At the completion of the fifth immersion period, the sample was dried, washed free of the sulfate salt, again dried, and each separate size sieved to determine the losses given in Table II. An average loss for the

sample weighted with respect to the grading of the material as received was then computed from the losses passing the original retaining (full-size) sieves and from the losses passing the half-size sieves. These values are given in Table III. Average losses were also computed as if the sample had been tested using grading 1 or using the alternate A grading.

The computation of the average weighted loss for grading 1 is shown in detail in Table IV. This grading requires that the 1½-in. to 1-in. and 1-in. to ¾-in. sizes be tested together as well as the ¾-in. to ½-in. and ½-in. to ⅜-in. sizes. In each case, the tested material contains 67 per cent of the larger size and 33 per cent of the smaller size. The original retaining sieve for the combination of the 1½-in. to 1-in. and 1-in. to ¾-in. sizes is here considered to be the ¾-in. sieve, and a half-size sieve would be the ⅜-in. sieve. Similarly, the ⅜-in. and No. 4 sieves are considered to be the original retaining and half-size sieves, respectively, for the combination of the ¾-in. to ½-in. and ½-in. to ⅜-in. sizes. The effect of using these combined sizes can be obtained as shown in Table IV by the use of conversion factors. The actual loss for the 1½-in. to 1-in. size passing the ¾-in. sieve is multiplied by 0.67 and added to 0.33 times the actual loss for the 1-in. to ¾-in. size passing the same sieve. The actual losses passing the ⅜-in. sieve for the ¾-in. to ½-in. and ½-in. to ⅜-in. sizes are similarly combined. The losses for these combined sizes as well as those for the two sizes which were not combined are used to compute the weighted average loss.

Table V shows the computation of the weighted average for the sample as if it had been tested using the alternate A grading. The 2-in. to 1½-in. and 1½-in. to 1-in. sizes are combined in equal weights for testing, but the 1-in. to ¾-in. and ¾-in. to ½-in. sizes are combined in the 67 : 33 ratio. In the table, appropriate conversion factors are used. The alternate A grading does not show any separation of the ½-in. to No. 4 size. As this size was separated on the ⅜-in. sieve and so tested, the losses for the ½-in. to ⅜-in. and ⅜-in. to No. 4 sizes have been combined in the same ratio that these sizes occurred in the original sample.

The results given in Tables II, III, IV, V may be summarized:

Method	Loss with Initial Retaining Sieve	Loss with Half-size Sieve
Grading 1....	13.5	7.6
Alternate A..	11.8	6.7
Alternate B..	15.0	8.5

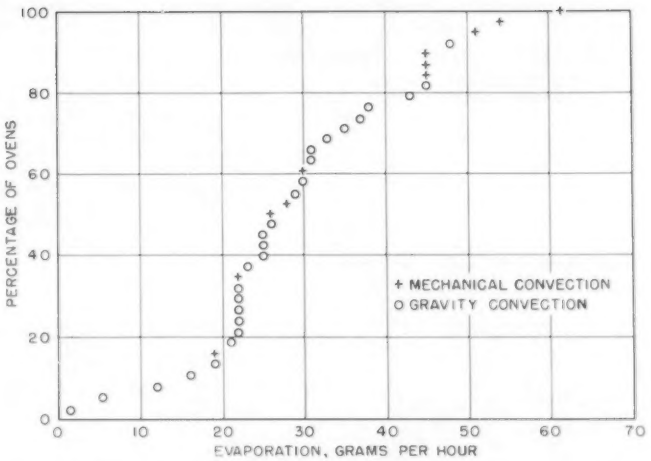

Fig. 1.—Rate of Evaporation of 38 Ovens Used in Accelerated Soundness Test. Percentage Having a Rate Smaller than or Equal to Amount Shown.

If the sample is tested by the grading 1 method and the loss considered as the material passing the initial retaining sieve, the material will not meet the requirement of 12 per cent given in ASTM Specification C 33 – 52 T[3] or in AASHO Specification M 80 – 51 for coarse aggregate for portland-cement concrete. If the sample is tested with the grading given in the specification as alternate A, the loss in the test will meet the requirements of the specification. Should the sample be tested using the individual sizes permitted under alternate B, it would fail to meet the requirement for soundness. If the loss is determined, as permitted, with half-size sieves, the material could be reported as of acceptable quality. Since almost all specifications for aggregate fail to mention which procedure of those available shall be used, it is possible that the acceptance or rejection of a given sample may depend entirely on which one of the six standard methods of test has been used.

Soundness Questionnaire

Reports of cooperative tests made, using the 1946 revision of the method, indicated that different laboratories failed to obtain a reasonable agreement in the results of tests on the same material. In an effort to determine the cause for this, Subcommittee III-e of ASTM Committee C-9 sent a questionnaire covering the sulfate soundness test to all laboratories known to use the test. The questionnaire covered in detail the apparatus used and the procedures followed by each laboratory. About fifty laboratories returned the questionnaire. Of these only three stated that all details of the method were followed exactly. Many laboratories indicated departures from the requirements of the specifications in matters which were considered immaterial. Others showed variations which admittedly could influence the test result but which were necessitated for one reason or another including shortage of help in the laboratory. In some respects, the inference could be drawn from replies to the questionnaire that some requirements of the method were too strict, or were unnecessary, and that the operator would conform to these only under protest.

The questionnaire furnished information concerning necessary or desirable changes in the requirements for the method. It was disclosed that many laboratories use pans instead of perforated containers for holding the test samples. Although the use of pans is not permitted in the present method, the only advantage of the use of perforated containers is that the sample can be drained more thoroughly and dried more rapidly. If laboratories have found that samples stored in pans can be brought to oven dryness in a suitable time, and it is presumed that this is so, the requirements of the method should be changed to accept this established practice. A test for the rate of evaporation of the drying ovens was suggested by the author and furnished some surprising results. The present specifications require that the oven "shall provide a free circulation of air through the oven and shall be capable of maintaining a temperature of 105 to 110 C." The questionnaire requested that a 1000-ml beaker containing 500 g of water at

[3] "Tentative Specification for Concrete Aggregates," 1955 Book of ASTM Standards, Part 3, p. 1145.

70 F be placed in the oven with a group of test samples to be dried and that the amount of water evaporated in a given time be determined.

Information regarding the rate of evaporation of the oven was furnished by 38 laboratories. The values reported were reduced to grams of water evaporated per hour, and plotted in Fig. 1 as a frequency distribution curve. The average rate was about 28 g per hr under the established conditions. The maximum and minimum rates were 61.5 and 1.5 g per hr. Twenty per cent of the ovens had a rate of 22 g per hr or less, and an equal number had a rate of 45 g per hr or more. Of 11 ovens of the mechanical convection type, 8 were reported to have an evaporation rate of 28 g per hr or more.

Significant differences are found between the work done by the various ovens on the basis of the evaporation rate and the reported time normally used for the drying cycle. The computed values for the total amount of water evaporated, assuming the rate remained constant, vary from 16 to 1080 g. Only 33 laboratories furnished definite statements of the time normally used during the drying cycle, and the ovens involved are rated as follows:

Grams of Water Evaporated during Drying Cycle	Number of Ovens
Less than 50	1
50 to 100	4
100 to 150	10
150 to 200	3
200 to 300	8
300 to 400	3
Over 400	4

It is entirely possible that some of the information from which the above values were computed was reported incorrectly. If so, the great differences shown between ovens may be reduced. There are however sufficient differences in the rate of evaporation of the various ovens to warrant inclusion in the method of requirements for the performance of the oven. A suitable revision of the requirements for the oven follows. The values included are based on the performance of the ovens reported in the questionnaire and may need some revision when a larger number of ovens is studied:

"The oven shall be capable of being heated continuously between 105 and 110 C (221 and 230 F) and the rate of evaporation of water shall be at least 25 grams per hour. This rate shall be determined by the loss of water from 1-liter Griffin low form beakers, each containing 500 g of water at 70 F, placed at each corner and the center of each shelf of the preheated oven, and heated for at least 4 hr during which period the doors of the oven shall be kept closed. The rate of evaporation shall be determined from the average loss for all beakers."

Consideration had been given to the exclusive use of magnesium sulfate in this method because the solubility of this salt is much less variable with change in temperature than that of the sodium salt. With the smaller variation in solubility, a saturated solution of the magnesium salt could more readily be maintained, and duplication of test results should be more certain. In the replies to the questionnaire, it was found that of 33 laboratories which used the method regularly, 21 used sodium sulfate exclusively or as an alternate with the magnesium salt. The fact that almost two-thirds of the reporting laboratories use sodium sulfate prevents consideration at this time of its elimination.

Replies to the questionnaire were received from 23 laboratories which regularly make the test on concrete aggregates proposed for use in construction financed by public funds. Eleven of these stated that material is rejected on the basis of the sulfate soundness test. The other twelve stated that material is not so rejected, but that the results of freezing-and-thawing or other tests, with or without service records, are considered. The use of the sulfate soundness test for the arbitrary rejection of aggregate is considered a highly questionable practice. Experience has shown that materials which have a low loss in the test generally have adequate resistance to frost action. It has also been shown that many materials having a high loss in the sulfate soundness test may not resist freezing and thawing, but this is not true of all materials. A low loss in the soundness test can be associated with resistance to weathering with more assurance than a high loss and lack of resistance to weathering. As an example, a sample of sandstone had a loss of 64 per cent in a five-cycle sodium sulfate test. Another portion of the same sample showed a loss of only 2 per cent when frozen and thawed 50 times in water. None of the fragments cracked or broke in freezing, and some or all of the loss may have been due to handling. As the stone in question is widely used for building with satisfactory results, it must be concluded that the results of the sulfate soundness test were quite misleading in this case.

It is considered highly advisable to add to the method a definite statement of the applicability of the test result. A suitable revision of the scope of the method could be made by the insertion of one sentence to have the text read as follows:

"This method covers the procedure to be followed in testing aggregates to determine their resistance to disintegration by saturated solutions of sodium sulfate or magnesium sulfate. It furnishes information helpful in judging the soundness of aggregates subject to weathering action, particularly when adequate information is not available from service records of the material exposed to actual weathering conditions. Generally the results of this test should not be used to reject materials, but aggregates having a low loss in this test can confidently be assumed to be resistant to the effects of freezing and thawing. Attention is called to the fact that test results obtained by the use of the two salts differ considerably, and in any application of these test results this difference must be recognized."

A number of replies in the questionnaire called attention to two other items which unquestionably have a marked effect on the test result. These are the preparation and maintenance of the sulfate solution. The method requires that a saturated solution of the salt be prepared and gives quite detailed instructions regarding the procedure to be followed. This does not appear to be a formidable undertaking, nor does it appear difficult to maintain that solution in its saturated condition provided the temperature of the solution can be controlled within the specified limits of 68 to 72 F. However, comment was made that the present requirements in the method call for an excessive amount of sulfate. Use of the amount indicated was found to furnish a solid crystalline mass of the sulfate in the container for the saturated solution. As the solid crystal does not enter solution readily, it is quite possible for the liquid in the container to become less than saturated even in the presence of this crystalline mass. The method of test now requires that the solution shall be stirred thoroughly immediately before use. It is doubted that this will cause material from the crystalline mass to enter solution unless the mass is broken to fine size. Consequently it is recommended that the method be revised to require breaking of the mass prior to agitation. The addition of a suitable statement to the note concerning the amount of salt to be used appears desirable.

Half-Size Sieves and the Reverse Cycle

The use of a sieve having openings one-half the size of those in the sieve used to prepare the sample has already been mentioned. When the initial retaining sieve is used, some otherwise sound fragments may pass the sieve due to minor chipping or breaking of corners

or edges. Although these chips would probably pass a half-size sieve, any considerable amount of material passing this sieve would be truly unsound, having suffered multiple cracking or marked disintegration. With elimination of the accidental inclusion of sound fragments in the loss, more concordant results between laboratories should be obtained.

In the present method, the sample is immersed in the sulfate solution for 16 to 18 hr, and then dried to constant weight. Most laboratories endeavor to maintain a 24-hr cycle and limit the drying period to 5 to 7 hr. As it has been shown that this period of drying may not be sufficient to dry the sample thoroughly, consideration was given to the use of a reverse cycle method. In this, the sample was immersed in the sulfate solution for about 6 hr, and dried in the oven for 16 to 17 hr. Previous work had indicated that coarse aggregate would absorb as much water in 6 hr, as it would in 24 hr, and that a drying period of the length shown would dry soundness samples even in ovens with a relatively low rate of evaporation. As thorough drying of the sample is necessary for the maximum crystallization of the sulfate salt, it was believed that the most effective results and the desired 24-hr cycle could be obtained with the reverse cycle method.

Tests of coarse aggregate were made to determine whether the use of half-size sieves or the reverse cycle would furnish more concordant results. Nine samples of stone of high to low loss were selected to determine the suitability of the procedures mentioned above. Each sample was crushed and screened to the 1½-in. to 1-in. size. Six test samples were prepared from each stone to make a total of 54 samples tested. Three samples of each material were subjected to five repetitions of the standard cycle consisting of an immersion period of 17 hr and a drying period of 6 hr. An equal number of samples was subjected to the reverse cycle with an immersion period of 6 hr and a drying period of 17 hr. At the completion of the fifth cycle, each sample was washed, dried, and sieved to refusal on the 1-in. and ½-in. sieves. The results obtained are shown in Table VI.

It will be observed that some test results differ to a marked extent from companion results for the same material. This is found in tests by each method. Computation of a mean deviation from the average for all results obtained by each method of treatment and each method of determining the loss furnished very nearly the same value for each of the four groups of results. This indicates that nonuniformity of the materials tested probably is responsible for the variations found in some of the test results. It is believed that the effect of the wild results will be cancelled out if all results obtained by each of the four methods of test are considered and that comparisons between average values for each method are valid.

These average values as well as values for mean deviations from the average are:

Method	Sieve used for Determination of Loss	Average of Losses for all Samples, per cent	Mean Deviation from Average, per cent
Standard	Full-size	27.1	28.2
	Half-size	12.8	31.5
Reverse cycle	Full-size	21.8	29.7
	Half-size	11.1	33.0

It was expected that the reverse cycle would insure more thorough drying of the samples than would be obtained with the standard method. Due to this, it was believed that the reverse cycle would furnish a greater loss for each material with more uniform results from sample to sample. These were not obtained because the oven used had a sufficient rate of evaporation to dry the samples in the 6-hr period provided in the standard method.

Several matters of interest are found in the results obtained in these tests. The smaller losses for the reverse cycle method indicate that insufficient time was allowed for either the absorption of the sulfate solution or the crystallization of the salt, or both. The better agreement between the average losses determine with the half-size sieve than those for the full-size sieve indicates that with reduction in size of the fragment tested, the time allowed in the reverse cycle for absorption or crystallization becomes less critical.

These results are further interpreted to indicate that the factor controlling the loss in the reverse cycle is the time for absorption of the sulfate solution. The rate of crystallization would be the same irrespective of the method used, but the rate of absorption would vary inversely with the size of fragment.

The rate of absorption of the sulfate solution may also be affected by plugging of the mouth of the capillary tube or crack in the fragment by the sulfate salt. The salt carried into the rock during each immersion period tends to be drawn toward the surface of the rock during the drying period and forms a deposit at or near the surface. During subsequent immersion periods, the solution must pass this plug. Since the solution is saturated, the plug of salt cannot be dissolved but must be softened until the solution can push past or around it. Considerable time probably is required for this, and the 6-hr immersion period in the reverse cycle may be insufficient to permit complete saturation of the larger sizes of coarse aggregate.

It is believed that with the adoption of requirements given above for the oven used in this method of test, samples may be dried in a period of 6 hr and

TABLE VI.—TESTS BY STANDARD AND REVERSE CYCLE METHODS ON 1½ TO 1 IN. STONE.

Sample	Loss Passing Full-size Sieve, per cent				Loss Passing Half-size Sieve, per cent			
	Test 1	Test 2	Test 3	Average	Test 1	Test 2	Test 3	Average
Standard Cycle								
No. 89805	45.0	39.2	45.6	43.3	20.5	16.9	15.9	17.8
No. 89812	19.9	32.4	8.1	20.1	8.7	11.6	3.0	7.8
No. 89813	17.2	19.5	33.3	23.3	6.8	5.6	8.2	6.9
No. 89889	8.0	6.2	2.0	5.4	4.5	4.5	1.4	3.5
No. 89890	74.0	84.2	77.2	78.5	51.7	55.6	57.5	54.9
No. 89892	10.1	4.2	4.1	6.1	3.9	1.5	3.6	3.0
No. 89916	13.4	6.0	14.1	11.2	3.8	0.5	4.8	3.0
No. 89918	14.2	7.0	32.7	18.0	6.5	2.1	16.5	8.4
No. 89920	40.2	37.5	36.7	38.1	7.1	8.8	12.6	9.5
Reverse Cycle								
No. 89805	41.9	28.7	56.4	42.3	17.3	9.3	23.2	16.6
No. 89812	7.3	15.1	4.0	8.8	2.3	5.3	2.0	3.2
No. 89813	12.5	17.7	22.2	17.5	5.4	6.4	9.8	7.2
No. 89889	2.8	4.3	4.6	3.9	2.8	2.6	4.1	3.2
No. 89890	85.3	53.4	94.5	77.7	55.1	34.6	68.9	52.9
No. 89892	12.7	6.1	12.9	10.6	5.4	3.6	4.7	4.6
No. 89916	0.8	6.5	8.6	5.3	0.1	1.9	2.2	1.4
No. 89918	19.6	11.0	14.5	15.0	9.8	6.3	6.2	7.4
No. 89920	18.5	8.8	19.2	15.5	4.9	0.3	5.5	3.6

use of a reverse cycle will be unnecessary. The use of the half-size sieve in the determination of the loss of samples of coarse aggregate is recommended.

Size of Sample

For a coarse aggregate graded from 2 in. to the No. 4 sieve, the present method requires a test sample weighing at least 4800 to 6050 g depending upon the grading chosen for the material tested. This material is separated into 3 to 6 portions depending on the grading to be used. If several samples are tested simultaneously, the total amount of material under test and the number of containers used may tax the facilities of the laboratory. In laboratories with limited personnel, it has been observed that there is a marked tendency for reduction in the amount of material tested. Although this reduction may have little or no effect on materials of uniform composition, it might tend to prevent reliable test results on nonhomogeneous materials. To determine whether any change could be made in the method which would permit the use of a smaller sample and reduce the labor and attention required, the results of tests of over 250 samples were studied. These samples had been tested in the laboratory of the Bureau of Public Roads during the period 1945 to 1953.

Most of the samples of coarse aggregate had a maximum size of 1½ or 2 in., and most had been tested by individual size of fragment—the alternate B method. The results were studied to determine whether the number of sizes of aggregate could be reduced and still obtain a loss approximating that for all sizes tested. Comparison of the averages for the entire group of samples indicated that the loss for the ½-in. to ⅜-in. size agreed closely with the loss for all sizes tested. From these data, it would appear that a good knowledge of the soundness of a material may be obtained by testing the ½-in. to ⅜-in. size alone. As a test of this size would require a test sample weighing only 500 g a great reduction in the weight of material and number of samples tested would result.

Losses through both the full-size and half-size sieves had been determined for about 150 of the samples tested by the alternate B method. To determine the effect on the specification requirement of a desirable change in the method of testing, Fig. 2 was prepared from data regarding these samples. This shows a comparison between the weighted average loss through the original retaining sieve of samples of 1½- or 2-in. maximum size coarse aggregate when tested as required for grading 1, and the loss of ½-in. to ⅜-in. aggregate passing a half-size sieve. Samples which had a weighted average loss of less than 2 per cent were not plotted nor were several samples with quite high losses.

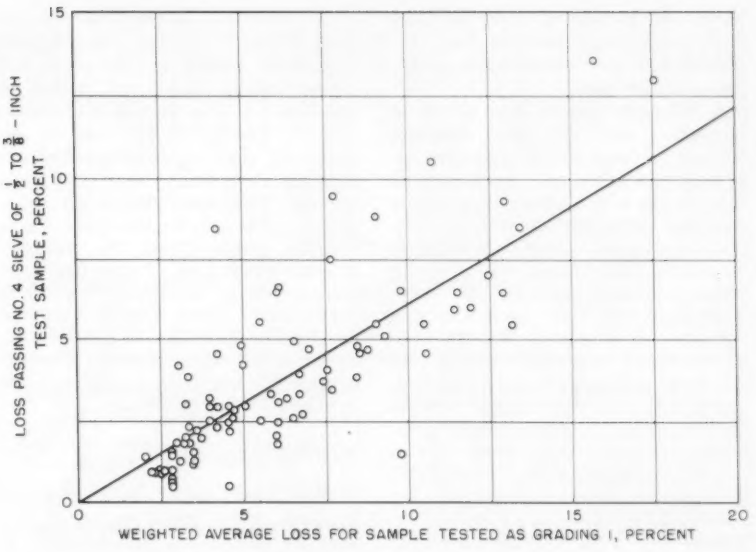

Fig. 2.—Comparison of Losses for Coarse Aggregate.

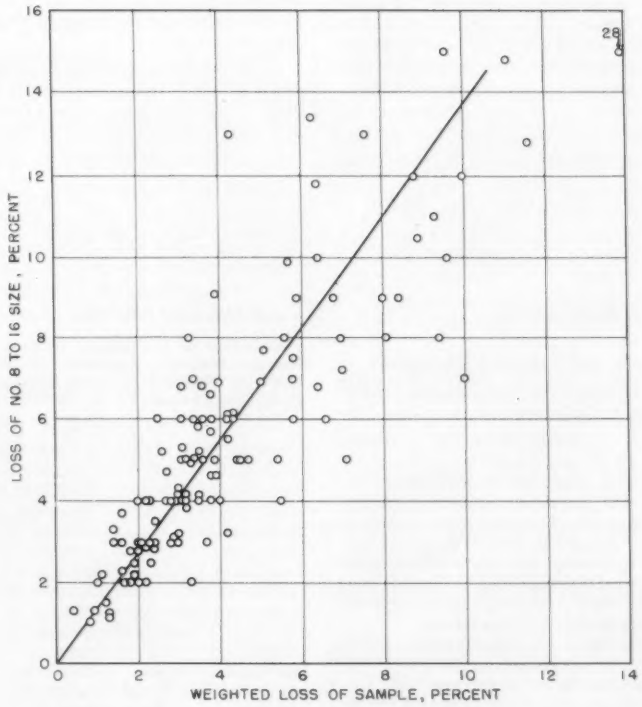

Fig. 3.—Comparison of Losses for Fine Aggregate.

ASTM Specification C 33 and AASHO Specification M 80 permit the acceptance of coarse aggregate for concrete having a loss in the sodium sulfate soundness test of 12 per cent. As both specifications are silent regarding the method for determining this loss, the method considered here is that involving the use of Grading 1 with the loss passing the original retaining or full-size sieve. Figure 2 shows that material of the quality indicated will have a loss of 7 per cent passing the half-size (No. 4) sieve when tested as ½-in. to ⅜-in. ma-

terial. It is believed that sufficient data have been presented to insure the reliability of this conversion in specification requirements.

A different problem was found in connection with the most desirable method for testing fine aggregate, especially natural sand. As a general rule, the loss of natural sand in a soundness test varies directly with the size of the sand grain. As the size of grain is reduced, the percentage of single grains of quartz increases, and these grains have very little loss in a soundness test. It is believed that the testing for soundness of fine grains of natural sand is largely wasted effort and that a large loss found in tests of such material probably resulted from accidental loss of some of the sample.

However, an adequate knowledge of the soundness of fine aggregate can be obtained by test of a single size of grain. The selection of the size tested must be based on the availability of that size in sand as customarily used and on the occurrence in that size of the more unsound grains. It is believed that the No. 8 to No. 16 size best meets these requirements. Although a coarser size may contain more unsound grains, many sands have very little material retained on the No. 8 sieve, and the use of this coarser size cannot be considered.

A comparison between the average loss weighted with respect to the grading of the sample as required by the present method of test and the loss for the No. 8 to No. 16 size is shown in Fig. 3. The loss in each case was determined from material passing the original retaining sieve. Approximately 125 samples of sand are represented. The loss for the single size is slightly greater than the weighted average for all sizes. A sand having an average loss for all sizes of 10 per cent would have a loss of about 13.5 per cent for the No. 8 to No. 16 size. Established specification limits for fine aggregate can readily be revised to make provision for this difference.

Recommendations

With view toward securing a dependable, reproducible method of test that can be used for a rapid appraisal of the soundness of aggregates, it is recommended that the following changes be made in AASHO Method T 104 – 46 or the similar ASTM Method C 88 – 46 T:

1. Revise the scope to indicate that the method is indicatory only; that it may be used for acceptance of material but that rejection should be based on other determinations such as freezing-and-thawing tests, inspection of ledges at the quarry (if the material is rock), or inspection of concrete prepared with the material.

2. Revise the requirements for the oven by the addition of performance determinations.

3. Revise the requirements for the samples to include only the ¾-in. to ¾-in. size of coarse aggregate and the No. 8 to No. 16 size of fine aggregate.

4. Determine the loss for coarse aggregates with the half-size (No. 4) sieve, but continue the use of the original retaining sieve for fine aggregates.

5. Revise the requirements for the maintenance of the solution to emphasize the necessity for thorough stirring and the breaking of caked salt.

6. Revise the requirements for sample containers to permit the use of perforated or nonperforated containers.

To accompany these changes in the method of test, a change from 12 to 7 per cent should be made in the requirements for the loss in the sodium sulfate soundness test given in AASHO Specification M 80 or ASTM Specification C 33 for coarse aggregate for concrete. A similar change for fine aggregate in ASTM Specification C 33 or AASHO Specification M 6 should be made, increasing the allowable loss from 10 to 13.5 per cent.

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Cellulose and Cellulose Derivatives

Part III[1] Interscience Publishers Inc., New York, N. Y., $12; 544 pp.

Part III covers in detail the physical and mechanical properties of cellulose and its derivatives. The information in this publication not only represents the experience of the author but the thoughtful consideration of his many reviewers as well. Thus this text may be considered a sound dissertation on the subject and of value to everyone in the field of cellulose.

ASTM members interested in cellulose, paper, wood, and industrial water will find the last chapter on Tests for Cellulose and Its Derivatives of great interest. This chapter lists the most up-to-date standard test methods published in the cellulose field and indicates those preferred by the author. The appendix covers a variety of tabular and graphical data concerning the properties of cellulose and commercially important cellulose derivatives as well as definitions and constants utilized in the industry.

[1] Parts I and II were reviewed in the May 1955 BULLETIN.

Clays and Clay Minerals

Proceedings of the Second National Conference, National Academy of Sciences, National Research Council, Washington, D. C., $4; 504 pp.

THE Second National Conference on Clays and Clay Minerals, held at the University of Missouri in late 1953, was jointly sponsored by the Committee on Clay Minerals of the National Academy of Sciences-National Research Council, the University of Missouri, and the State Geological Survey of Kansas. The proceedings of the Conference contain 36 papers by 64 contributors whose fields include geology, mineralogy, soil chemistry and soil mechanics, physics, colloid chemistry, and ceramics. These proceedings are an important contribution to the literature on clays and clay mineralogy and will become an essential part of the library of everyone investigating these materials.

Soil and Soil-Aggregate Stabilization

Highway Research Board, 2101 Constitution Ave., Washington, D. C.; $3; 175 pp.

AN ISSUE in this series that should be of considerable interest to ASTM members is *Bulletin 108*. This Bulletin contains the Symposium on Soil and Soil-Aggregate Stabilization.

The first papers describe soil as a natural body having distinct characteristics inherited from the materials from which it is derived and the environment which produced it, and discuss the fundamental nature of soil as it has been learned from several different branches of science. The main body of papers describes our present knowledge of the art and science of stabilization of soils, whether by control of grain-size distribution and characteristics of the soil itself or by the addition of organic or inorganic compounds to produce artificially or to maintain a stable condition.

Pulp and Paper Manufacture, Bibliography and United States Patents (1954)

Technical Association of the Pulp and Paper Industry, New York, N. Y.; 521 pp.

THIS publication contains references to articles of interest to the paper industry, arranged by subject, such as test methods, specifications, cellulose, etc. A complete author, subject, and patent index is included.

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News items concerning the activities of our members will be welcomed for inclusion in this column

NOTE—*These "Personals" are arranged in order of alphabetical sequence of the names. Frequently two or more members may be referred to in the same note, in which case the first one named is used as a key letter. It is believed that this arrangement will facilitate reference to the news about members.*

A number of active ASTM members were honored at the 52nd annual convention of the American Concrete Inst. in Philadelphia in February. **Walter H. Price,** head, Engineering Laboratories, U. S. Bureau of Reclamation, Denver, Colo., was elected for a two-year term as vice-president. Elected to three-year terms as directors were **Clayton L. Davis,** technical service director, Universal Atlas Cement Co., New York City; **Bruce E. Foster,** assistant chief, Concreting Materials Section, National Bureau of Standards, Washington, D. C.; **J. W. Kelly,** professor of civil engineering, University of California, Berkeley, Calif.; and **Lewis H. Tuthill,** chief, Concrete Laboratory, U. S. Bureau of Reclamation, Denver. **Franklin R. McMillan,** consulting engineer, Asheville, N. C., received the Henry C. Turner Medal "for forty years of outstanding leadership in discovering and disseminating knowledge of the basic principles of concrete and concrete construction." **John I. Parcel,** partner, Sverdrup and Parcel, St. Louis, Mo., was presented the Alfred E. Lindau Award "for inspired authorship and teaching of structural principles applicable to reinforced concrete design." **Charles S. Whitney,** partner, Ammann & Whitney, New York City and Milwaukee, received, with his associates, Boyd G. Anderson and Edward Cohen, the Wason Medal "for the most meritorious paper" of the year, "Design of Blast Resistant Construction for Atomic Explosions," which appeared in the March, 1955 ACI *Journal*. **Morton O. Withey,** dean emeritus of the College of Engineering, University of Wisconsin, Madison, was elected to ACI Honorary Membership. Dean Withey was 1943 president of the Institute, 1931 recipient of the Wason Research Medal for his paper "Some Long-Time Tests of Concrete," and 1947 recipient of the Henry C. Turner Medal recognizing "forty years of outstanding contributions to knowledge and understanding of concrete and reinforced concrete." Affiliated with ASTM since 1907, Dean Withey served a term as a Director of the Society, and has been very active in a number of the technical groups, principally Committee C-9 on Concrete and Concrete Aggregates where he was elected to honorary membership in 1950.

Allen Abrams recently retired as vice-president in charge of research and development, Marathon Corp., Rothschild, Wis. He had represented the company membership since 1928, serving on Committees D-6 on Paper and Paper Products, and D-9 on Electrical Insulating Materials. Mr. Abrams resides at 815 10th St., Wausau, Wis.

Henry B. Allen retired as executive vice-president and secretary of **The Franklin Institute. John S. Burlew** was recently appointed director of The Institute, which is an ASTM Charter Member.

Roger G. Bates, chemist, Physical Chemistry Section, National Bureau of Standards, Washington, D. C., is recipient of the 1955 Hillebrand Award, presented annually by the Chemical Society of Washington. He is cited for "studies of the thermodynamic properties of electrolytic solutions and standardization of the pH scale."

Alfred F. Bauer, chief engineer, Doehler-Jarvis Div., National Lead Co., Toledo, Ohio, has assumed added duties as assistant general manager.

Fred H. Baumann retired March 31 as chief of Testing Division, New Jersey State Highway Dept., Trenton. Mr. Baumann was representative of the Highway Dept. membership since 1942, serving through the years on at least eight of the technical committees. He was chairman of Committee D-4 on Road and Paving Materials 1948–1950.

Arnold O. Beckman, founder and president of Beckman Instruments, Inc., Fullerton, Calif., is 1956 president of the Los Angeles Chamber of Commerce. A leader in the Los Angeles campaign to control smog, Dr. Beckman was named by the Governor of California as chairman of the Special Commission on Air Pollution. Beckman Instruments, Inc., recently announced establishment in the Stanford community of the Shockley Semiconductor Laboratory headed by **William Shockley,** inventor of the junction transistor, as director.

Lynn S. Beedle, assistant director, Fritz Engineering Laboratory, Lehigh University, Bethlehem, Pa., was recipient of one of three of the first Research Awards of the American Society of Civil Engineers. Dr. Beedle's citation stated the award was "for his experimental and theoretical investigations into the fundamental nature of residual stress in structural steel. These studies have brought about a better

(*Continued on page 90*)

Society Emblem Made Up in Pin or Watch Charm

A facsimile of the Society emblem is shown full size in the margin. This emblem is made up in the form of a pin or watch charm, with the letters in gold on a black enamel background. The gold pin with safety catch, and full name and year of membership engraved on the back, costs $7.00.

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Income is reward...

*French forecaster 1503-1666

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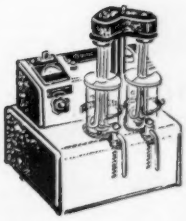
CIRCLE 140 ON READER SERVICE CARD PAGE 121

rapid separation of metals by mercury cathode

DYNA-CATH



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Viscosity directly in centipoises . . .

HOEPPLER VISCOSIMETER
PRECISION MODEL

The Hoeppler Viscosimeter provides a fast, accurate method of determining the viscosity of gases, liquids, oils, plastics, syrups, viscous tars and dark liquids. From 0°C. to 100°C. Direct readings in centipoises (or centistokes). From 0.01 to 1,000,000 centipoises. Accuracy 0.1% to 0.5%. Small sample (30cc) required. Results consistent and reproducible.

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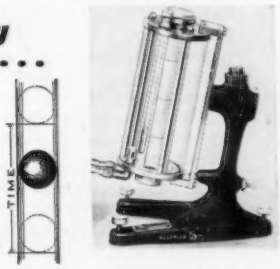

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on the principle of the suspended level

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Measures viscosity with an error not greater than ±0.1%, when used at efflux times of 80–1000 seconds. The smallest listed capillary is used for light fuel oil or kerosene, the others for lubricating oils. The temperature of the bath should be controlled with ±0.02°F.

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(*Continued from page 88*)

understanding of the magnitude, variation, and distribution of residual stresses as well as the influence of this stress on the strength of structural steel members, particularly columns. The research contributions by this investigator and his fellow workers may lead to changes or modifications of existing specifications, which will, in turn, reflect greater efficiency and economy to the profession in the design of structural members."

Attilio L. Bisio, formerly with American Smelting and Refining Co., South Plainfield, N. J., is now on the engineering staff of Sylvania Electric Products, Inc., Jackson Heights, L. I., N. Y.

Delmar L. Bloem, formerly assistant director of engineering, is now associate director of engineering of both the National Sand and Gravel Assn. and the National Ready Mixed Concrete Assn., Washington, D. C.

Arthur Bloomberg, until recently chemical engineer, Chemical Construction Corp. Linden, N. J., is now chief chemist, International Salt Co., Research Laboratory, New York City.

J. Paul Blundon, of Keyser, W. Va., longtime member of the Society, is retiring from the practice of engineering.

Dan T. Bradley was named to the new post of vice-president in charge of engineering and sales of Harris Products Co. Cleveland, Ohio.

John A. Byers has retired as vice-president, James B. Clow and Sons, Chicago, Ill.

R. B. Clary, formerly of the Clary Engineering Co., Lyons, Kans., is now city engineer, Junction City, Kans.

Henry R. Clauser, for some years managing editor, has been appointed editor of *Materials & Methods.* Author of the book "Practical Radiography for Industry," Mr. Clauser is active in ASTM Committees B-9 on Metal Powders and Metal Powder Products, and E-7 on Nondestructive Testing.

Arthur W. Claussen, longtime member of the Society, recently retired as sales engineer, McWane Cast Iron Pipe Co., Birmingham, Ala., after 30 years' service. Mr. Claussen may be addressed at 2117 Shades Crest Road, Birmingham.

Harrison D. Comins, professor of civil engineering, University of Florida, Gainesville, represented ASTM at the inauguration of Julius Wayne Reitz as president of the University of Florida on February 17, 1956.

(*Continued on page 92*)

Sperry

ultrasonic inspection news

40-Foot Aluminum Extrusions Inspected Under Water

How to inspect 40-foot, 1850-lb. aluminum extrusions for internal defects prior to machining into helicopter blades?—Piasecki Helicopter Corp., Morton, Pa., required an immediate answer to this problem.

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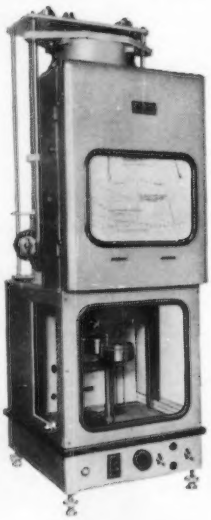

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FOR FURTHER INFORMATION CIRCLE 145 ON READER SERVICE CARD PAGE 121

(*Continued from page 90*)

James M. Copeland has been appointed senior project metallurgist at International Business Machines Corp., Endicott, N. Y. He has been on the engineering staff in the Metallurgical Laboratory since 1951.

C. E. Crompton, formerly chief, Isotopes Div., U. S. Atomic Energy Commission, Oak Ridge, Tenn., is now associate technical director, National Lead Co., of Ohio. Mr. Crompton is vice-chairman of Committee E-10 on Radioactive Isotopes.

Harry W. Dietert, chairman of the board, Harry W. Dietert Co., Detroit Mich., has been named 1956–57 vice-president of the American Foundrymen's Society.

Myron B. Diggin was elected vice-president and director of Hanson-Van Winkle-Munning Co., Matawan, N. J. He served as technical director the last nine years, and was made an assistant vice-president in 1954.

Claude E. Emmons, who retired some months ago as regional manager, technical service, The Texas Co., Los Angeles, Calif., is continuing his membership in the Society (dating from 1928). Mr. Emmons is a past-chairman of the Southern California District Council, and still active in this group. He may be addressed at 322 S. Mansfield, Los Angeles.

Irving Flaumenhaft is serving as president, and **E. J. Dunn Jr.,** as treasurer of the New York Paint and Varnish Production Club for 1956.

R. F. Geller has retired as technologist,

(*Continued on page 94*)

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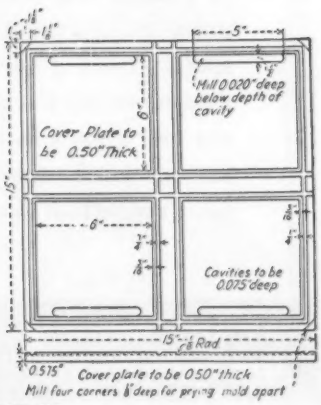
5"
Mill 0.020" deep below depth of cavity
Cover Plate to be 0.50" Thick
6"
15"
Cavities to be 0.075 deep
15" C.R. Rad
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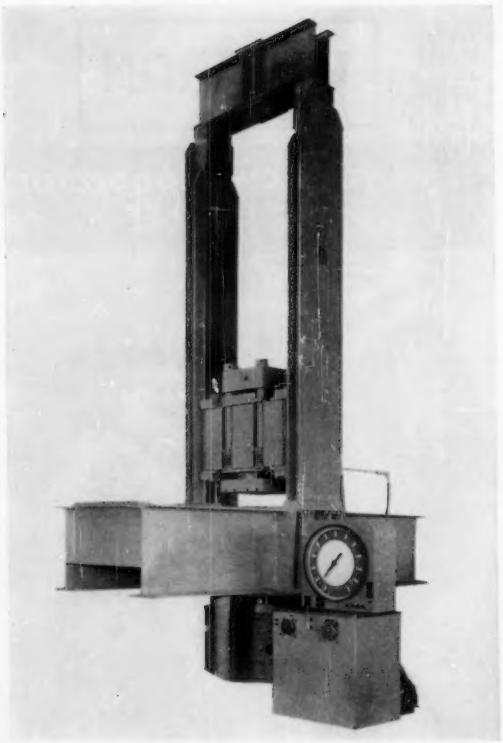

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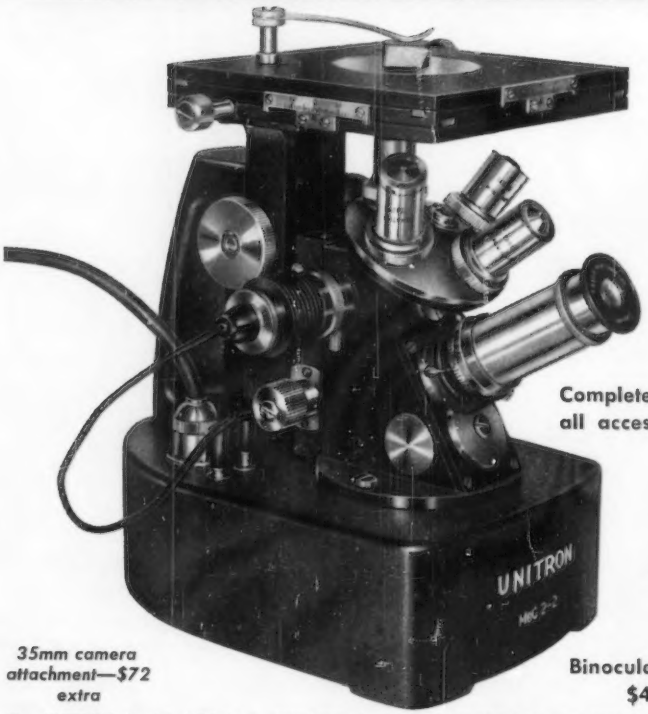

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(*Continued from page 92*)

National Bureau of Standards, Washington, D. C. Dr. Geller served as secretary of Committee C-21 on Ceramic Whiteware and Similar Products 1948–1954. He resides at 5427 York Lane, Bethesda, Md.

Roy A. Gezelius has been named assistant vice-president, General Steel Castings Corp., Eddystone, Pa.

Daniel J. Girardi has been appointed to the post of metallurgical engineer in charge of research and process control, Timken Roller Bearing Co., Canton, Ohio.

Raymond Harsch has retired as manager, Asphalt Dept., Shell Oil Co., San Francisco, Calif. He is succeeded by **C. V. Kiefer.**

Jesse E. Hobson recently resigned as director of Stanford Research Institute, Stanford, Calif. The necessity for a period of complete relaxation and rest prompted Dr. Hobson's decision.

James C. Hodge was elected a vice-president of Warner & Swasey Co., Cleveland, Ohio. For the present he is concerned with problems of manufacturing. He recently resigned as president of Wellman Engineering Co.

J. I. Hoffman has been appointed chief of the Metallurgy Division at the National Bureau of Standards, Washington, D. C. He succeeds **J. G. Thompson,** who is retiring after more than 35 years of Government service. Mr. Hoffman has been assistant chief of the Chemistry Division at the Bureau since 1952. He also vacates the position of chief of the Surface Chemistry Section which he has held since 1947.

William M. Holaday, who for many years has represented the Sustaining Membership of Socony Mobil Oil Co., New York City, and has been active in the work of various committees, including Committee D-2 on Petroleum Products and Lubricants, is on leave from his company, and is serving as Deputy Assistant Secretary of Defense (Research and Development), Washington, D. C. He was in Government service previously. For some time director of laboratories, and now named coordinator, new products development for Socony Mobil, Mr. Holaday has assumed individual membership in ASTM.

Mark N. Holmes, formerly associated with May, McEwen, Kaiser Co., Burlington, N. C., is now director, quality control and research, Burlington Industries, Inc.

T. H. Holzer, formerly chief draftsman, Roylyn, Inc., Glendale, Calif., has been named assistant chief engineer.

Harry Hyams, of the Shell Oil Co., London, England, has been elected to honorary membership in ASTM Committee D-2 on Petroleum Products and Lubricants. Mr. Hyams has championed closer ties between the Institute of

(*Continued on page 96*)

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FOR FURTHER INFORMATION CIRCLE 151 ON READER SERVICE CARD PAGE 121

(*Continued from page 94*)

Petroleum and Committee D-2 for many years, and was instrumental in making the joint publication of the "ASTM-IP Petroleum Measurement Tables" possible.

Robert R. Johnson has been named chief engineer for Minnesota Rubber and Gasket Co., Minneapolis, Minn. He was previously general manager of Master Tools, Inc., a subsidiary of Minnesota Rubber.

Russell W. Karry is now research assistant, University of Illinois, Urbana.

Theodore J. Kauer, formerly chief engineer, Ohio Turnpike Commission, Columbus, is now chief engineer, The Holmes Construction Co., Wooster, Ohio.

Russell B. Keeney has been appointed assistant testing laboratory manager, International Business Machines Corp., Endicott, N. Y. He has been on the IBM engineering staff in various capacities since 1937.

Earl F. Kelley, chief, Physical Research Branch, U. S. Bureau of Public Roads, Washington, D. C., was one of three leading highway engineers presented with the Roy W. Crum Award by the Highway Research Board for "outstanding research achievement." Presentation was made at the Board's 35th annual meeting in Washington in January. Affiliated with ASTM for the past thirty years, Mr. Kelley has been very active in many of the technical committees, heading Committees C-13 on Concrete Pipe and D-4 on Road and Paving Materials as chairman. He also is a past-chairman of the Washington, D. C., ASTM District Council. In recognition of distinguished service to the Society in the field of highway materials and for sustained support of other activities he was presented an ASTM Award of Merit in 1954.

John L. Kimberley, former secretary of American Zinc Inst., was appointed executive vice-president following retirement of Ernest V. Gent.

Joseph F. Knasieqicz, formerly with Victor Adding Machine Co., Chicago, is now quality control engineer, Ford Motor Co., Aircraft Engine Div., in the same city.

Elmer Leuliette is now president, Plas-Ti-Con, Mount Holly, N. J.

K. G. Mackenzie, petroleum consultant, Westport, Conn., was honored recently by the American Standards Assn. in recognition of his achievements in the development of American standards. A Past-President and Honorary Member of ASTM, Mr. Mackenzie represents the Society on the Standards Council which is responsible for the technical program of the ASA. His citation read: "The American Standards Association presents this certificate in recognition of contributions to the establishment of voluntary standards and in appreciation of sound advice and devotion of energy to the furtherance of the standards movement as a means of advancing the national economy."

J. Miguel Marquez B., until recently with Compania Shell de Venezuela, is now attached to Bethlehem Steel Co., Inc., Bethlehem, Pa., on a Special Commission of Studies for the Government of Venezuela.

K. R. Martin has been appointed to the new position of coordinator, engineering services of Fort Wayne Corrugated Paper Co., Hartford City, Ind., in his new position directing the company laboratory as well as coordinating the firm's manufacturing engineering activities.

The Master Builders Co., Division of American-Marietta Co., Cleveland, Ohio has announced expansion of the company's research laboratory administrative and

(*Continued on page 98*)

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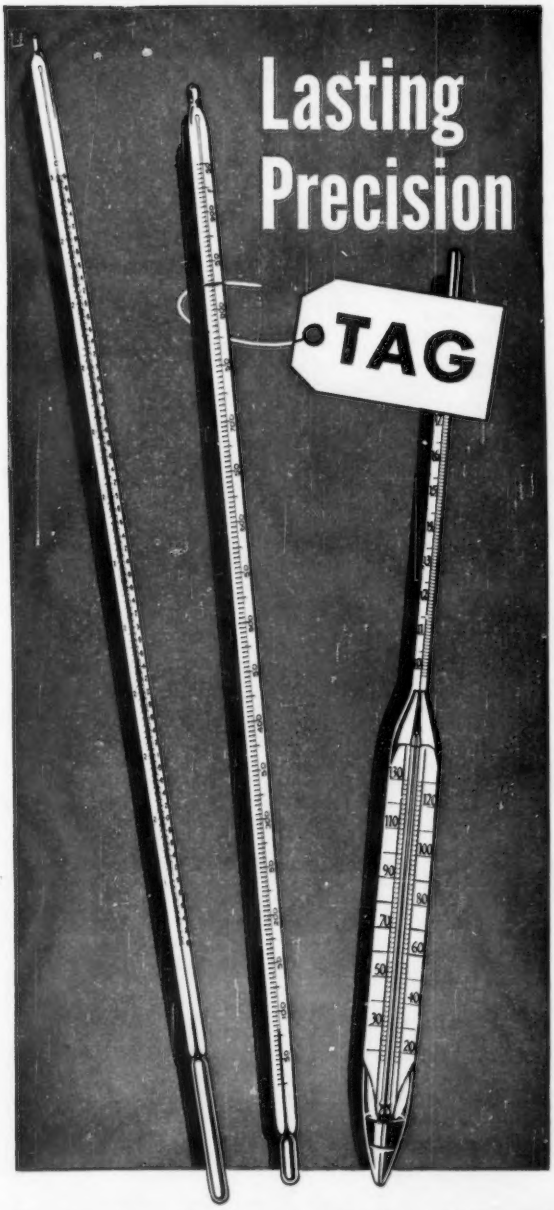
FOR FURTHER INFORMATION CIRCLE 152 ON READER SERVICE CARD PAGE 121



Favorites the world over because of their readability and permanent accuracy TAG etched stem thermometers are available in A.S.T.M., Extreme Precision, and Standard Grades—as well as in Armored Types for special applications. Also A.P.I. Scale Hydrometers in plain or combined forms, and a precision grade for general use. Catalog gladly sent on request. WESTON Electrical Instrument Corporation, 617 Frelinghuysen Avenue, Newark 5, New Jersey . . . *manufacturers of Weston and TAG Instruments.*

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◀ **Connects rubber tubing to glass tubing without a lubricant**

8853.
Showing 12 mm o.d. glass tubing being inserted in ⅜-inch bore rubber tubing.

RUBBER TUBING EXPANDER, ELLIOTT SAFETY TYPE (Patent applied for). For safe, convenient connection of rubber tubing to glass tubing without need for a lubricant. Rubber tubing can be stretched readily at the open end for easy access of a cylindrical object. The stretch is effected by three parallel tines whose tips are simultaneously diverged by a system of levers upon compressing the handles. The device is of chromium plated metal with plastic grips and has been approved by Safety Committee of one of the country's largest industrial laboratories.

To operate, tines are inserted into end of rubber tubing which can be spread open by squeezing the handles. The glass tubing is guided between and slightly beyond ends of the tines which are then unlocked by pulling a trigger. Tines are retracted without dislodging the glass tubing simply by repeating pressure on handles.

For use with rubber tubing from approximately ¼-inch to ⅝-inch bore. Not intended for use with pressure or vacuum tubing with thick, rigid wall, or with plastic tubings such as Tygon or polyethylene, which are less elastic than rubber.

Overall length of 12 inches permits connection of tubing in assemblies at junctions which ordinarily might not be accessible.

8853. Rubber Tubing Expander, Elliott Safety Type, as above described. With directions for use. **14.00**
10% discount in lots of 12.

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CIRCLE 154 ON READER SERVICE CARD PAGE 121

(*Continued from page 96*)

supervisory staff. Appointments are **Stephen W. Benedict,** elected to vice-president of research and engineering; elevation of **Herbert K. Cook** to director of engineering, and **Thomas M. Kelly** to director of research; and addition of **Perry H. Petersen** as assistant director of engineering. **Edward W. Scripture, Jr.,** with Master Builders since 1930, is retiring as vice-president in charge of research, but will be retained in the capacity of consultant.

At a recent meeting of the Metal Treating Inst. **L. L. McArthur,** chief metallurgist Rollway Bearing Co., Inc., Syracuse, N. Y. and his co-author were presented the Annual Metal Treating Institute Achievement Award for their article on "Dimensional Control System Minimizes Finishing Costs."

Claude R. McMillan, Jr., formerly on the faculty of the University of South Carolina School of Engineering, is now registered engineer and land surveyor, Columbia, S. C.

ASTM Director **John C. Moore,** formerly associated with the National Paint, Varnish and Lacquer Assn., Inc., Washington, D. C., has opened consulting offices at 6306 Winston Drive, Bethesda, Md., for individual paint manufacturers, users, and raw material suppliers, and for companies or organizations serving the paint and related industries. Mr. Moore recently resigned as technical director of the Association where he had served for the past eight years. Prior to this he had served in technical and executive management positions in the paint and the petroleum refining industries. He was president of the Federation of Paint and Varnish Production Clubs in 1947, previously serving in several capacities in local and national sections of the Federation.

Coleman P. Morgan, formerly chief chemist, Vulcanized Rubber and Plastics Co., Morrisville, Pa., has opened consulting offices—Coleman P. Morgan Associates, Yardley, Pa.

Gene M. Nordby, until recently on the civil engineering staff at the University of Colorado, has joined the faculty of Purdue University as associate professor of structural engineering.

L. T. Nuckols recently retired as chief engineer, Southern Region, Chesapeake & Ohio Railway Co., Richmond, Va. He is succeeded by **T. F. Burris.** Mr. Nuckols had represented the Sustaining Membership of his company for many years, serving on Committee A-1 on Steel and several subcommittees.

Stanley R. O'Dette is now petroleum engineer, Service Dept., Alsop Engineering Corp., Milldale, Conn.

Sidney H. Perlman, formerly general manager and chief engineer, Electric Hotpack Co., Inc., Philadelphia, Pa., is now president, Temperature Engineering Corp., in the same city.

James A. Pettit, Jr., until recently associated with Plastoid Corp., Hamburg, N. J., is now with Engineered Wire and Cable, Inc., Winsted, Conn.

Garnet P. Phillips, general supervisor of foundry research, International Harvester Co., Chicago, Ill., has been nominated to serve as national director of the American Foundrymen's Society for a three-year term.

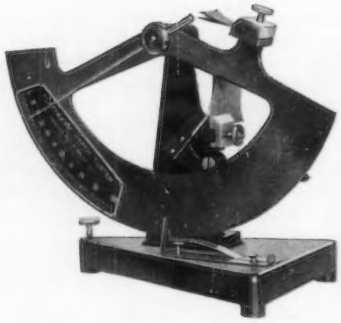
Milo L. Phillips, formerly with the Aluminum Company of America and the Wm. F. Jobbins Co., has joined Alloys & Chemical Manufacturing Co., Inc., Cleveland, Ohio, in the capacity of sales engineer and technical consultant.

Charles U. Pierson, Jr., is now technical director, Southern Cement Co., Birmingham, Ala. He was previously with Marquette Cement Co., Chicago, Ill.

Elmer R. Queer, assistant director, Engineering Experiment Station, Pennsyl-

(*Continued on page 100*)

ELMENDORF TEARING TESTER



The Elmendorf Tearing Test has long been an ASTM standard. Measuring the internal tearing resistance of textiles, paper and sheet materials, the Elmendorf test is the practical one for evaluating wearing quality. **It is a measure of service.**

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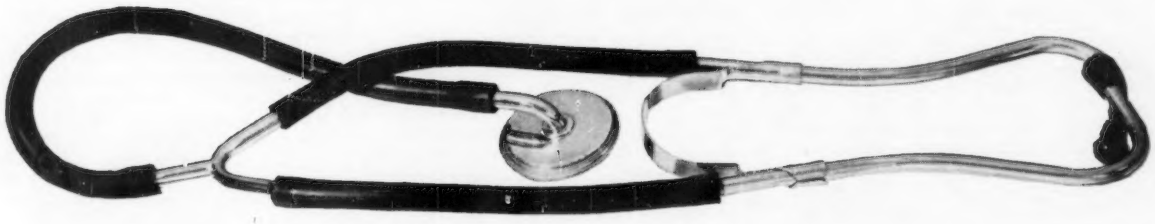
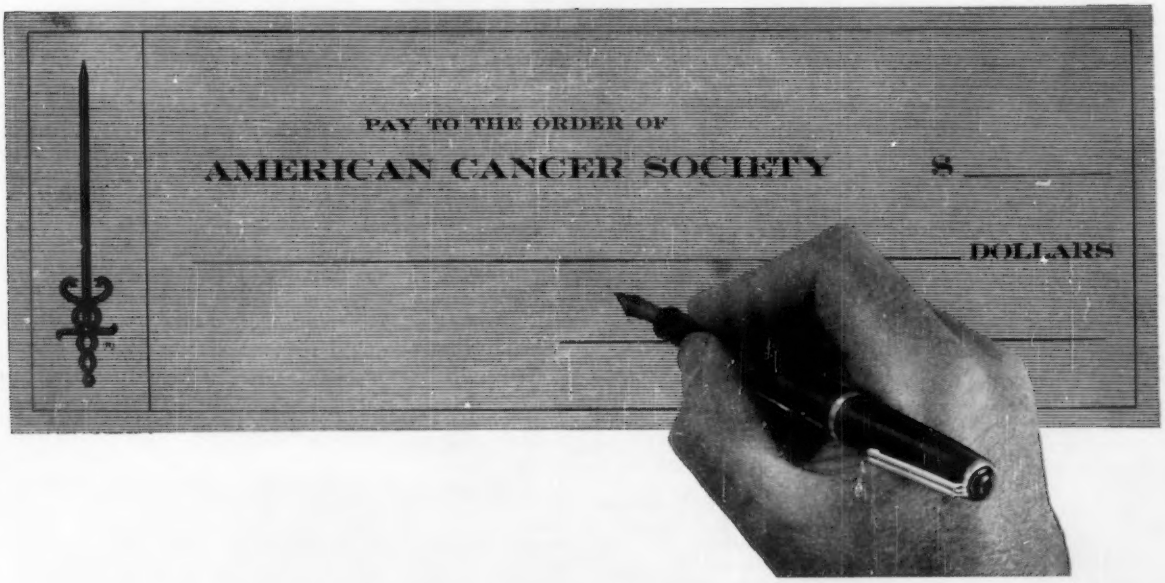
A checkup

Of every 100 persons who get cancer 25 will be saved, 75 will die. Of these, many will die *needlessly*, because with present knowledge they could be saved by early detection and prompt treatment. Play fair with yourself and your family . . . have that cancer checkup soon.



and a check

There has never been enough money to carry on all the research that needs to be done. Can you afford to remain indifferent to the enemy that strikes 1 out of every 4 Americans? Your donation—large or small—can help save lives. Someday, perhaps your own.



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(*Continued from page 98*)

vania State University, was installed as second vice-president of the American Society of Heating and Air-Conditioning Engineers at its recent annual meeting in Cincinnati. Professor Queer is chairman of ASTM Committee C-16 on Thermal Insulating Materials.

Arthur J. Raymo, formerly works manager, Fitzgibbons Boiler Co., Inc., Oswego, N. Y., is now on the engineering staff of General Electric Co., Atomic Power Equipment Dept., San Jose, Calif.

Glen C. Riegel recently retired as chief metallurgist for Caterpillar Tractor Co., Peoria, Ill., where he had been employed since 1926. With his retirement from Caterpillar, Mr. Riegel has accepted appointment as consulting metallurgist to the Metals Handbook Committee of the American Society for Metals. Mr. Riegel has written numerous articles on induction heating and hardening, and has a number of patents issued in this and other fields of engineering. In ASTM Mr. Riegel has been active in Committee A-1 on Steel and its Subcommittee IV on Spring Steel and Steel Springs.

R. L. Sanford, for many years on the staff of the National Bureau of Standards, and longtime chairman and secretary of ASTM Committee A-6 on Magnetic Properties, recently served as a representative of the Society in a review of the patent files for the Chief Archivist of the United States. A number of engineering societies cooperated in this activity. Dr. Sanford was particularly concerned with subjects relating to the general properties and testing of materials, and also because of his interest and knowledge reviewed specifically the area of magnetic materials.

Paul Schwarzkopf, president of Schwarzkopf Development Corp. and the American Electro Metal Corp., Yonkers, N. Y., and the Metallwerk Plansee in Reuttee, Tyrol, Austria, received the Wilhelm Exner Medal of the Oesterreichische Gewerbeverein, one of Austria's highest decorations. He was recognized for his contributions to Austria's industrial and technical development.

Arthur G. Scroggie, manager, Characterization Lab., Textile Research Lab., E. I. du Pont de Nemours and Co., Inc., Wilmington, Del., received the 1956 Harold DeWitt Smith Memorial Award of ASTM Committee D-13 on Textile Materials for outstanding achievement in the field of textile fiber utilization. Presentation was made at the meeting of Committee D-13 in New York City in March.

W. A. Selvig recently retired as chief, Chemistry and Physics Section, Branch of Bituminous Coal, U. S. Bureau of Mines, Pittsburgh, Pa. He had served the Bureau for 44 years, all at the Pittsburgh Station. A member of the Society since 1921, Mr. Selvig has been very active for the past 35 years in Committee D-5 on Coal and Coke where he continues to serve on the Advisory Group and several subcommittees. In 1953 he was given an ASTM Award of Merit "for outstanding contributions to knowledge of the chemistry of American coals and the development of testing methods, and particularly for notable service for 28 years as Secretary of Committee D-5, and later for four years as Chairman."

Thomas H. Sheehan, formerly with Houdaille-Hershey Corp., Detroit, Mich., is now chief manufacturing engineer, Sunbeam Corp., Rossevelt, Ill.

Ralph A. Sherman, assistant director, Battelle Memorial Inst., Columbus, Ohio, was installed recently as treasurer of the Society of Heating and Air-Conditioning Engineers. Dr. Sherman has represented the Institute for many years in ASTM and on Committee D-5 on Coal and Coke.

Frederic D. Shottland is now consulting radio engineer, at 40 Rock Spring Ave., West Orange, N. J. He was previously associated with The Daven Co., Potentiometer Div., Newark, N. J., as chief engineer.

E. J. Slater recently retired as vice-president in charge of refining, Champlin Refining Co., Enid, Okla.

Earle C. Smith, chief metallurgist, Republic Steel Co., Cleveland, Ohio, was "saluted" in a recent issue of *The Iron Age* as one who "can gain the theoretical knowledge for modern manufacturing without losing touch with practical things." Despite high professional and company standing, and numerous honors accorded Mr. Smith for his work in metallurgy he "remains modest and easy to approach." In ASTM Mr. Smith has been active in Committee A-1 on Steel for many years.

Joseph A. Smith recently retired as chief chemist, Esso Standard Oil Co., Baltimore, Md.

Hubert R. Snoke, nationally known authority on bituminous roofing materials, has been named assistant chief of the Building Technology Division at the National Bureau of Standards. Dr. Snoke, who will continue as chief of the Floor, Roof and Wall Covering Section, has been with NBS since he graduated from Lebanon Valley College in 1920. Active in ASTM Committee D-8 on Bituminous Waterproofing and Roofing Materials since 1929, he has made valued contributions to the work of this and other of the Society's technical groups. He has served as chairman of Committee D-8 for the past four years.

Lee M. Springer, formerly mechanical engineer, B. & M. Engineering Co., Glendale, Calif., is now chief, Design Group, University of Southern California Engineering Center, Los Angeles.

David Steinman, internationally noted bridge engineer of New York City, has received two new decorations from the French Government—the Cross of Commander of the Order of Merit and Education and the Cross of High Officer of the Order of Merit for Research and Invention.

Richard Summers, formerly general manager, Cupa Manufacturing Corp., Bridgeport, Conn., is now associate director, Bridgeport Testing Laboratory.

John G. Thompson, chief of the Metallurgy Division of the National Bureau of Standards, has retired after more than 35 years of Government service. Dr. Thompson has made outstanding concontributions in fields of research pertaining to the preparation of pure metals, the evaluation of their properties, gases in metals, special refractories, corrosion, and powder metallurgy, and is the author of more than 35 technical publications. During World War II he conducted researches on beryllium-aluminum alloys under the auspices of the War Metallurgy Committee. He has served on many technical committees of various engineering societies. In ASTM he has been especially active in Committee A-5 on Corrosion of Iron and Steel, where he served as vice-chairman. He has also served through the years on Committees A-1 on Steel, A-3 on Cast Iron, B-2 on Non-Ferrous Metals and Alloys, B-3 on Corrosion of Non-Ferrous Metals and Alloys, B-9 on Metal Powders and Metal Powder Products, and the Joint Committee on the Effect of Temperature on the Properties of Metals. Dr. Thompson resides at 4114 Aspen St., Chevy Chase, Md.

Ralph H. Titley has retired as materials division chief, Testing Lab., Public Service Electric and Gas Co., Maplewood, N. J. A member of the Society for the past 23 years, Mr. Titley has been very active in a number of the technical committees including A-5 on Corrosion of Iron and Steel, D-9 on Electrical Insulating Materials, D-11 on Rubber and Rubber-Like Materials, and D-20 on Plastics. He also has served since 1949 as a member of the New York District Council. Mr. Titley resides at 81 Bryant Ave., Springfield, N. J.

William von Fischer, who has been head of the Department of Chemistry and Chemical Engineering at Case Institute of Technology for the past eight years, has been appointed Coordinator of research and development for the Glidden Co. He will assume duties at Glidden in Cleveland, Ohio, at the close of this academic year.

Stanton Walker, director of engineering, National Sand and Gravel Assn., and National Ready Mixed Concrete Assn., Washington, D. C., was one of three leading highway engineers to receive in January the Roy W. Crum Award for Distinguished Service from the Highway Research Board. Mr. Walker's citation

(*Continued on page 102*)

THE BECKMAN
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Extended Spectral Range
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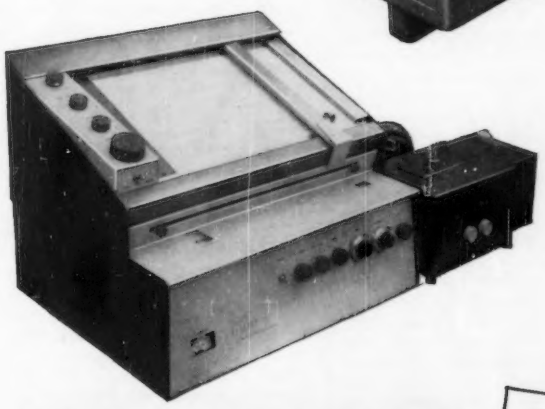

Extended Spectral Range covers not only the ultraviolet and visible spectra, but the near-infrared. Many materials which absorb in the infrared also absorb in the near-infrared, and may now be analyzed easily and quickly with the Model DK.

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CIRCLE 157 ON READER SERVICE CARD PAGE 121

(*Continued from page 100*)

recognized "outstanding accomplishments in the fields of concrete and aggregates, where he has been prominent in research, education and the development of specifications and test methods." He has been active in the development of concrete technology for approximately 40 years. A former ASTM Director, and very active in the Society since 1920, Mr. Walker has made valued contributions to the work of Committee C-9 on Concrete and Concrete Aggregates, as well as a number of the other tehcnical groups, heading several subcommittees and sections. He served as Secretary of C-9 for 15 years. His activities throughout the years have been characterized by recognition of the practical elements so fundamental to the effectiveness of specifications and methods of testing. In appreciation of loyal and effective service he was granted an ASTM Award of Merit in 1951.

Fred J. Walls, in charge of Detroit Technical Section, International Nickel Co., has moved up from the position of treasurer to secretary of The Engineering Society of Detroit.

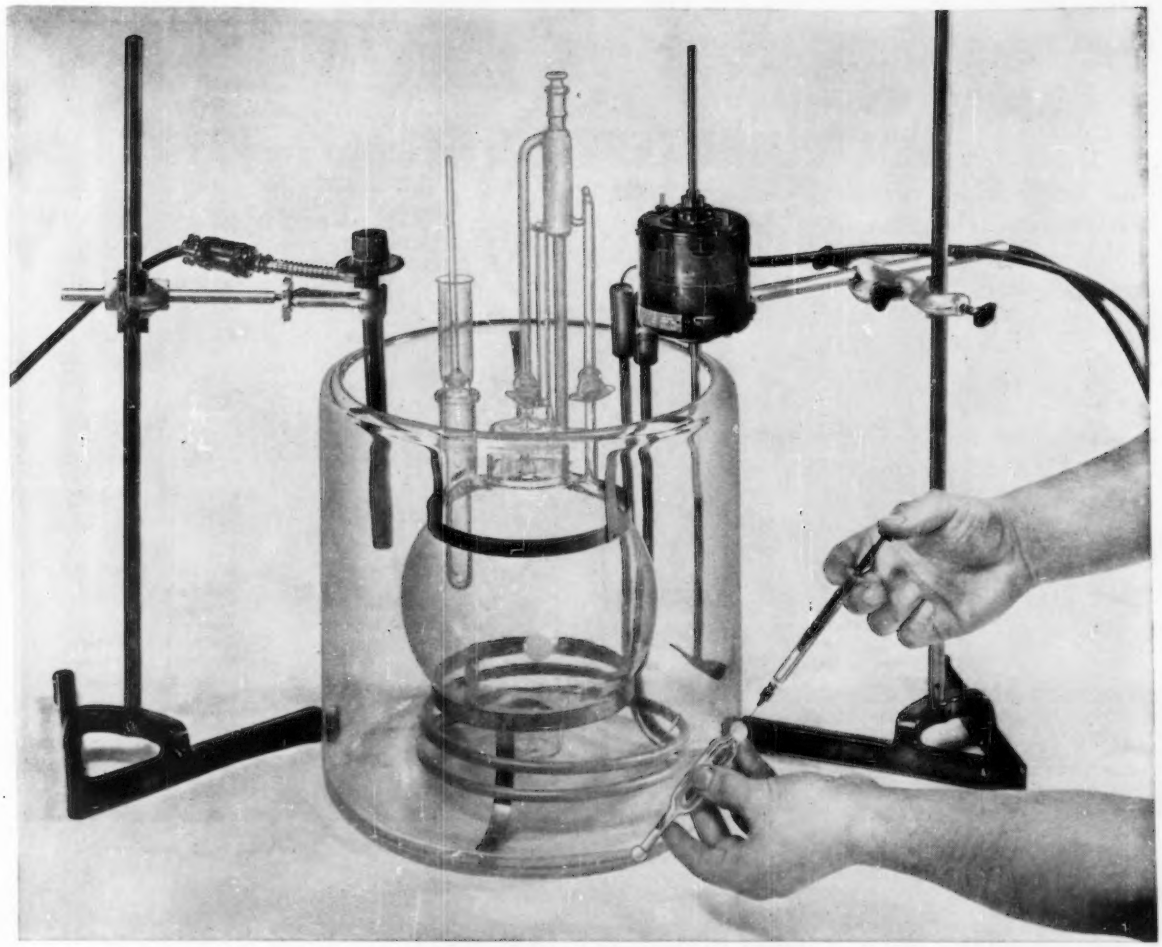
Walfrid Warner, formerly metallurgist, Inland Steel Co., Chicago, Ill., is now technical representative, Phoenix Manufacturing Co., Joliet, Ill.

John F. Williams, Head of the Bureau of Customs Laboratories throughout the United States, retired January 31. Memorandum from the Treasury Department mentioned that Col. Williams served the Department with distinction from 1921 to 1956, and had been a capable executive of the Division of Technical Services since 1936. Colonel Williams commanded the 915th Air Base Security Battalion in the Infantry and Air Corps of the United States Army in World War II, and received several decorations. He was presented the Albert Gallatin Award at a reception on January 27 at the Willard Hotel. He is the author of five publications on subjects from the fiber length of raw cotton to nitro-aminoguanidine, methanol, and spirit beverages. He was a member of ASTM for many years, serving on Committee D-13 on Textile Materials.

Louis Harry Winkler, metallurgical engineer, Bethlehem Steel Co., Inc., Bethlehem, Pa., and ASTM Past Director and Honorary Member, was one of five recipients of Missouri Honor Awards for Distinguished Service in Engineering presented by the University of Missouri at a special convocation in March on the program of the Centennial of Engineering Education at the University. An outstanding authority on railroad steel products and on wire rope, wire, and wire rods, and on steel tubular products, Mr. Winkler was cited by Dean Croft in recognition of his "leadership in the development of technical codes for the design, manufacture, and testing of steel rails, locomotive forgings, wire and wire rods and tubular products," and for his "high ability to understand his fellow man, to provide effective and responsible technical leadership in the steel manufacturing industry." Active in ASTM since 1913, Mr. Winkler has served on many of the technical committees, including Committee A-1 on Steel where through the years he has contributed to the work of many subcommittees and sections; he has long been a member of the Advisory Committee, currently heads Subcommittee XIII on Methods of Testing, and is vice-chairman of Subcommittee I on Steel Rails and Accessories.

T. Van Dyke Woodford, formerly with Poz-L-Ash Corp., Birmingham, Ala.,

(*Continued on page 104*)



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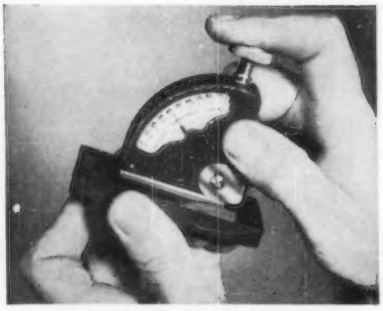

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(*Continued from page 102*)

is now sales manager, Walter Handy Co., Evanston, Ill.

ASTM Director **Kenneth B. Woods,** Head of the School of Civil Engineering at Purdue University, was elected chairman of the executive committee of the Highway Research Board at its recent annual meeting. Professor Woods, who was previously associated with the Bureau of Tests in the Ohio State Department of Highways, has been engaged in highway engineering—both teaching and research—at Purdue since 1939. As Director of the Joint Highway Research Project (a cooperative undertaking between the University and the Indiana State Highway Commission) he has supervised research on a multiplicity of subjects, ranging from frost action in soils to traffic paints and paving materials. Active in the technical as well as administrative work of ASTM, Professor Woods currently is vice-chairman of Committee D-4 on Road and Paving Materials, and represents the Society on the NRC Highway Research Board.

Anthony J. Zino, Jr., former general sales manager, Joseph Dixon Crucible Co., Jersey City, N. J., is now vice-president, sales, Dixon Sinaloy, Inc., Stamford, Conn. (subsidiary of Joseph Dixon Crucible Co.)

NEW MEMBERS.....

The following 202 members were elected from January 18 to March 13, 1956, making the total membership 8251 . . . Welcome to ASTM

Note—Names are arranged alphabetically—company members first, then individuals. Your ASTM Yearbook shows the areas covered by the respective Districts.

CHICAGO DISTRICT

Barco Manufacturing Co., V. W. Breitenstein, chief engineer, 500–530 N. Hough St., Barrington, Ill.

Twin Disc Clutch Co., W. F. Shurts, vice-president, engineering, 1310 Preston St., Rockford, Ill.

Argonne National Laboratory, Library Dept., Box 299, Lemont, Ill.

Barnum, William M., testing engineer, Northern States Power Co., 1600 N. Chestnut Ave., Minneapolis 3, Minn.

Conn, Harry, chief engineer, Scully-Jones and Co., 1901 S. Rockwell, Chicago 8, Ill.

Eller, John V., technical controller, H. P. Smith Paper Co., 5001 W. 66th St. Chicago 38, Ill.

Esty, F. B., chief engineer, Wisconsin Motor Corp., 1910 S. 53rd St., Milwaukee 46, Wis.

Gaus, Michael P., graduate student, Civil Engineering Course, University of Illinois, Urbana, Ill. For mail: 111 S. Lincoln Ave., Urbana, Ill.[A]*

Jaeger, Gene, Sales Dept., Dolese & Shepard Co., Box 227, La Grange, Ill.

Koch, Raymond F., assistant to president, Felt & Tarrant Manufacturing Co., 1735 N. Paulina St., Chicago 22, Ill.

Marshall, R. H., chief metallurgist, The Frank G. Hough Co., Libertyville, Ill.

Minnesota, State of, Petroleum Division, Department of Taxation, A. H. Stassen, 555 Wabasha St., St. Paul, Minn.

Munse, William H., research professor of civil engineering, University of Illinois, 119 Talbot Laboratory, Urbana, Ill.

Rohlen, K. V., president, Crane Packing Co., 6800 S. Oakton St., Morton Grove, Ill.

Sabin, T. M., assistant to manager, Gas Dept., The Pure Oil Co., Room 2368, 35 E. Wacker Dr., Chicago 1, Ill.

Tredinnick, V. A., works manager, Walworth Co., Kewanee, Ill.

Wright, D. J., chief metallurgist, Caterpillar Tractor Co., E. Peoria, Ill.

Zutaut, John J., assistant technical advisor, Chicago Quartermaster Purchasing Center, 1819 W. Pershing Rd., Chicago 9, Ill. For mail: 6241 S. Laflin St., Chicago 36, Ill.

CLEVELAND DISTRICT

Columbia Fire Brick Co., The, M. L. Hamaker, president, 612 First National Bank Bldg., Canton 2, Ohio.

Marsh Wall Products, Inc., Carl A. Schroeder, product engineer, Dover, Ohio.

Ohio Edison Co., E. F. Dissmeyer, chief engineer, 47 N. Main St., Akron 8, Ohio. [S]**

* Denotes Associate members.
** Denotes Sustaining members.

(*Continued on page 106*)

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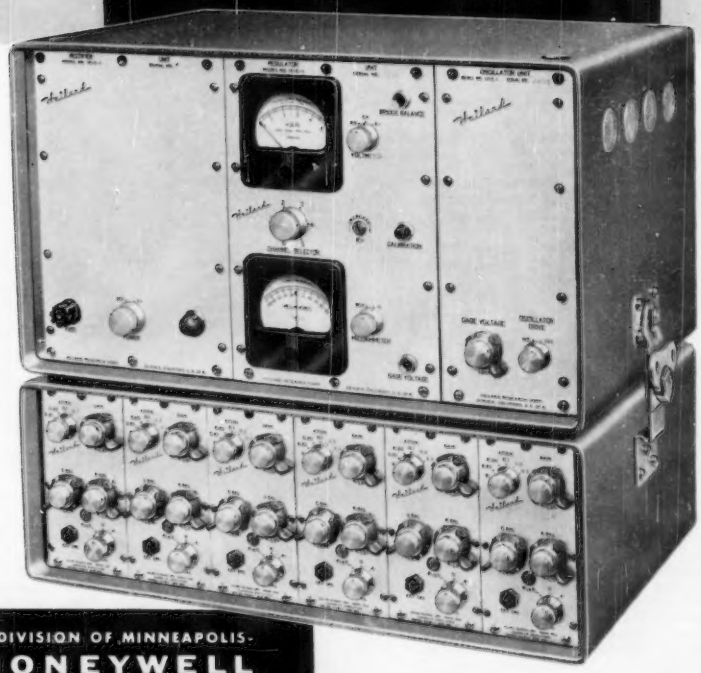

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(*Continued from page 104*)

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(*Continued on page 108*)

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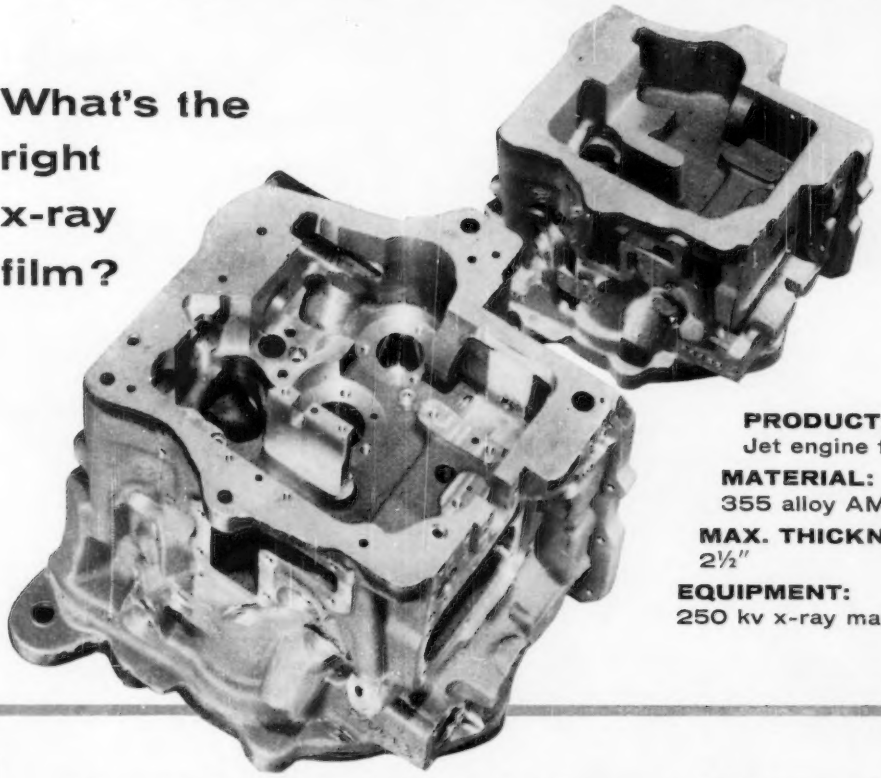

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MAX. THICKNESS:
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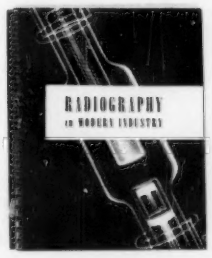

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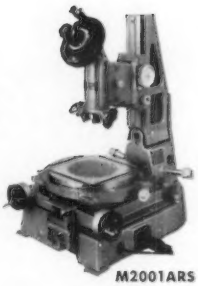

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(*Continued from page 106*)

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CIRCLE 165 ON READER SERVICE CARD PAGE 121

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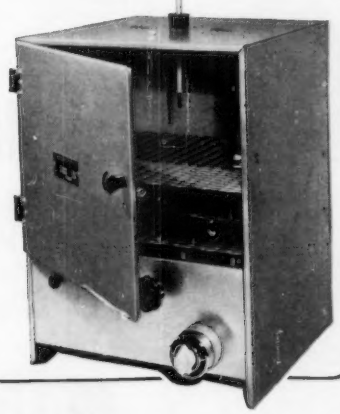

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(*Continued from page 108*)

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Barber Machinery, Ltd., P. S. Grant, assistant general manager, 4608 MacLeod Trail, Calgary, Alberta, Canada.

Baxenden Chemical Co., Lt., The, T. R. Ames development manager, Paragon Works, Baxenden, nr. Accrington, Lancashire, England.

Eldorado Mining and Refining, Ltd., J. McN. Jardine, chief chemist, 149 John St., Port Hope, Ont., Canada.

Husky Oil and Refining, Ltd., L. J. Campbell, manager of refining and manufacturing, 815 Sixth St., W., Calgary, Alta., Canada.

Mullard Radio Valve Co., Ltd., F. M. Walker, chief valve engineer, New Road, Mitcham Junction, Surrey, England.

Biblioteca del Colegio Provincial de Arquitectos, Infanta y Humboldt, Havana, Cuba.

Canada, Department of National Health and Welfare, Occupational Health Div., Morris Katz, consultant, Atmospheric Pollution, Jackson Bldg., Ottawa, Ont., Canada.

Cairns, William M., chief, Materials and Process Engineering Laboratory, Canadair, Ltd., Box 6087, Montreal, P.Q., Canada.

de Castro, Jose Ma., civil engineer, 849 Highway 54, Quezon City, Philippines. [A]

Emery, John William, manager, Ready Mixed Concrete (W.A.) Pty., Ltd., Box 1, Rivervale, Western Australia.

Gadjah Mada University, Laboratory for Materials Testing, Ir Soebono, Assistant lecturer, Technical Faculty, 6 Kebondalem, Jogjacarta, Java, Indonesia.

Granler, Svante, director, AB Svenska Elektronrör, Stockholm 20, Sweden.

Heffernan, G. R., managing director, Premier Steel Mills, Ltd., Box 348, Edmonton, Alta., Canada.

Institut de Ceramique Francaise, P. de Groote, manager, 6 Grande Rue, Severes (S. & O.), France.

Japan Cement Engineering Assn., No. 1(2) Akasaka Daimachi, Minatoku, Tokyo, Japan.

Kluit, L. K. Tempelman, professional engineer, Canadian British Associates, 774 Columbia St., Suite 25, New Westminister, B. C., Canada.

Marquez Q., Jorge, Los Cherros, Av. El Centro, Qta, Maurace, Caracas, Venezuela.

Mendez, Raimundo, civil engineer, Conser-

(*Continued on page 112*)

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● The "LINDLEY"

with 2" fixed gauge length

Simple, robust, practical, with each dial division representing 1/20,000" extension of testpiece, clearly indicating length alterations of 1/100,000". Magnification factor—1250:1.

Maximum *range* of extension: 0.1" on specimen, 20 revolutions on dial. Instrument always in static balance about axis of testpiece—no errors due to weight of instrument bending the specimen. Minute distortions set up while gripping and testing sheet and strip materials do not affect the dial reading. No frictional lag. Dial gauge is swivelled into most convenient position for reading. Simple to use, easy and quick to attach. Carbide tipped gripping screws.

Type No. 1—mainly for .505" specimens, can be used on sections up to .625" thick and up to .750" wide.

Type No. 2—for specimens from 1/2" to 1 1/2" diameter or up to 1 1/8" square.

Accessories available: wire grips, adaptors for round or flat microbars, adaptors for compression tests, vibrator for dial.

Write for Bulletin No. A-20

GRIES INDUSTRIES, INC.

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CIRCLE 167 ON READER SERVICE CARD PAGE 121

The New AUTOMET is on Display at the ASTM Convention Atlantic City, June 18-22

See the new Buehler Automet Polisher Attachment in operation.
Holds 6—1" or 5—1¼" specimen mounts for automatic mass production precision polishing.
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Also on display will be the new Buehler Electro Polisher together with other Buehler equipment.
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FOR FURTHER INFORMATION CIRCLE 168 ON READER SERVICE CARD PAGE 121

(*Continued from page 110*)

vacion Cordialidad Cartagena, Calle Real de Manas, 18-20, Cartagena, Colombia.

Mohr, Naftali, chief chemist, Sefen, Ltd., Jordan Valley, Israel.

Roorkee, University of, Central Library, Officer-in-Charge, Roorkee, India.

Royer, Maurice, consulting engineer; and professor of resistance of materials, Department of Civil Engineering, Laval University, Quebec 6, P. Q., Canada. For mail: 831 St., Cyrille St., W., Quebec 6, P. Q., Canada.

Steven, William, superintendent, Development and Research Department Lab., The Mond Nickel Co., Ltd., Wiggin St., Birmingham 16, England.

Saran, Chandra Bhusan, in charge, Jeep Manufacturing Div., Mahindra & Mahindra, Ltd., Gateway Bldg., Apollo Bunder, Bombay 1, India.

Villasenor, Ignacio, plant manager, Altos Hornos de Mexicao, S. A., Apartado No. 121, Monclova, Coah., Mexico.

Walton, B. V. E., manager, Dussek Brothers (Canada), Ltd., Box 209, Belleville, Ont., Canada.

DEATHS...

Russell J. Anderson, works manager, Belle City Malleable Iron Co., Racine, Wis. (January 20, 1956). Representative of company membership since 1944, also representative of company for same period on Committee A-7 on Malleable-Iron Castings.

C. A. Booker, transmission line engineer, New England Power Service Co., Boston, Mass. (1955). Representative of company since 1933 on Committee B-1 on Wires for Electrical Conductors, and its Subcommittees IV on Conductors of Copper and Copper Alloys, and VII on Conductors of Light Metals.

Paul John Cowell, head of Works Lab., National Carbon Co., Division of Union Carbide and Carbon Corp., Fostoria, Ohio (January 13, 1955). Member since 1948.

Colonel C. H. Crawford, consulting engineer, "Maplewood," Chesapeake, Lawrence County, Ohio (May 9, 1955). Colonel Crawford met with a fatal accident while operating his farm tractor at home. Member of the Society since 1914, he had served since 1949 on ASA Sectional Committee B-36 on Standardization of Dimensions and Materials of Wrought-Iron and Wrought-Steel Pipe and Tubing, as representative of the American Society of Mechanical Engineers.

Joseph D. Davis, distinguished chemist associated with the Bureau of Mines, United States Department of the Interior for many years, died January 20, 1956, at the age of 73 in his home at 1307 Macon Ave., Pittsburgh, Pa. A native of Middleport, Ohio, Mr. Davis headed the Bureau's Coal Carbonization Section at the Central Experiment Station in Pittsburgh for 33 years until his retirement in April, 1952. Internationally famous for the many practical techniques he developed in the field of coke-making, Mr. Davis received the Department of Interior Distinguished Service Award in 1950 for his advances in coal research. Mr. Davis served as a Consulting Member of ASTM Committee D-5 on Coal and Coke for 16 years.

R. C. Ehrman, Metals Research Labs., Electro Metallurgical Co., Kokomo, Ind. Representative of his company since 1953 on Committee E-3 on Chemical Analysis of Metals and its Division F on Ferrous Metals.

Colonel Evan Ewen Kimble, pioneer manufacturer of laboratory and pharmaceutical glassware, died March 15, 1956, at his home in Ventnor, N. J., at the age of 87. He was founder of the Kimble Glass Co., Vineland, now a subsidiary of the Owens-Illinois Glass Co., of Toledo. In 1951 he received the Scientific Apparatus Makers Assn. Award for his contribution to the scientific instrument industry and his work in the chemical glassware field. The son of a Tuckahoe, N. J sea captain, he went to work at 12 in a glass plant at Millville, N. J.; and in the early 90's moved westward, working in plants in Pennsylvania, Ohio, and Indiana. In 1901, with three employees and $3000 capital, most of which was borrowed, he set up his own shop in Chicago. The Kimble Glass Co. has long been represented in ASTM, for many years through the individual membership of Herman K. Kimble, son of the colonel, and more recently though the company's Sustaining Membership, with representation on certain of the technical committees.

A. M. Meyers, chief engineer, Kansas City Structural Steel Co., Kansas City, Kans. (July 15, 1955). Member since 1938.

Thomas J. Mooney, production manager Laclede Steel Co., St. Louis, Mo. (January 21, 1956). A well-known steel industry executive, Mr. Mooney was a member of ASTM since 1948. A veteran of World War I with the Purple Heart, Mr. Mooney was active in the American Iron and Steel Institute and other steel industry groups developing specifications and standards for steel products.

Ernest J. Morgan, sales engineer, Gilman Paper Co., Cellucord Division, Gilman, Vt. (December 21, 1955). Representative of company membership in the Society, also representative of his company on Committee D-13 on Textile Materials and several subcommittees.

M. F. Nichols, director, Nichols Laboratories, Knoxville, Tenn. (1954). Member since 1939.

R. A. Noyes, manager, Testing Laboratory, International Business Machines Corp., Poughkeepsie, N. Y. (January 14, 1956). Member since 1952.

Henry Paige, graduate student, Columbia University, New York City; former graduate student, University of Pennsylvania metallurgical engineering course, Philadelphia (October 5, 1955). Student member of the Society since 1951.

Frank E. Payne, president, Crane Packing Co., Chicago, Ill. (November 20, 1955). Member since 1944.

Edmond L. Sweeney, superintendent, Everett Plant, Boston Consolidated Gas Co., Everett, Mass. (March 1955). Member since 1946.

D. W. Taylor, associate professor of soil mechanics, Massachusetts Institute of Technology, Cambridge, Mass. (December, 1955). Representative of Institute since 1940 on Committee D-18 on Soils for Engineering Purposes and Subcommittee R-5 on Structural Properties of Soil.

Russell C. Webeck, works engineer, Walworth Co., Kewanee, Ill. (February 6, 1956). Member since 1946.

OTHER SOCIETIES' EVENTS

April 29–May 3—**The Electrochemical Society,** Mark Hopkins Hotel, San Francisco, Calif.

April 29–May 4—**Society of Motion Picture and Television Engineers,** Hotel Statler, New York City.

April 30–May 2—**Association of Iron and Steel Engineers,** Annual Spring Conference, Lord Baltimore Hotel, Baltimore, Md.

May 3—**Non-Ferrous Founders' Soc.,** Annual Membership Meeting, Atlantic City, N. J.

May 3–9—**American Foundrymen's Soc.,** Annual Convention and Exhibit, Atlantic City, N. J.

May 3–4—**Society of Naval Architects and Marine Engineers,** Spring Meeting, Sheraton-Mt. Royal Hotel, Montreal, Quebec, Can.

May 4—**American Assn. of Spectrographers,** Annual Conference, Chicago, Ill.

May 6–9—**American Institute of Chemical Engineers,** Roosevelt Hotel, New Orleans, La.

May 7–11—**American Welding Society,** Annual Meeting and Exposition, Hotel Statler, Buffalo, N. Y.

May 8–11—**American Society of Mechanical Engineers,** Hotel Statler, Buffalo, N. Y.

May 9–10—**National Association of Corrosion Engineers,** University of Buffalo, Buffalo, N. Y.

May 9–11—**American Institute of Chemists,** Annual Meeting, Hotel Statler, Boston, Mass.

May 10–11—**Operations Research Soc. of America,** Annual Meeting, Sheraton-Park Hotel, Washington, D. C.

May 16–18—**Society for Experimental Stress Analysis,** Spring Meeting, Wm. Penn Hotel, Pittsburgh, Pa.

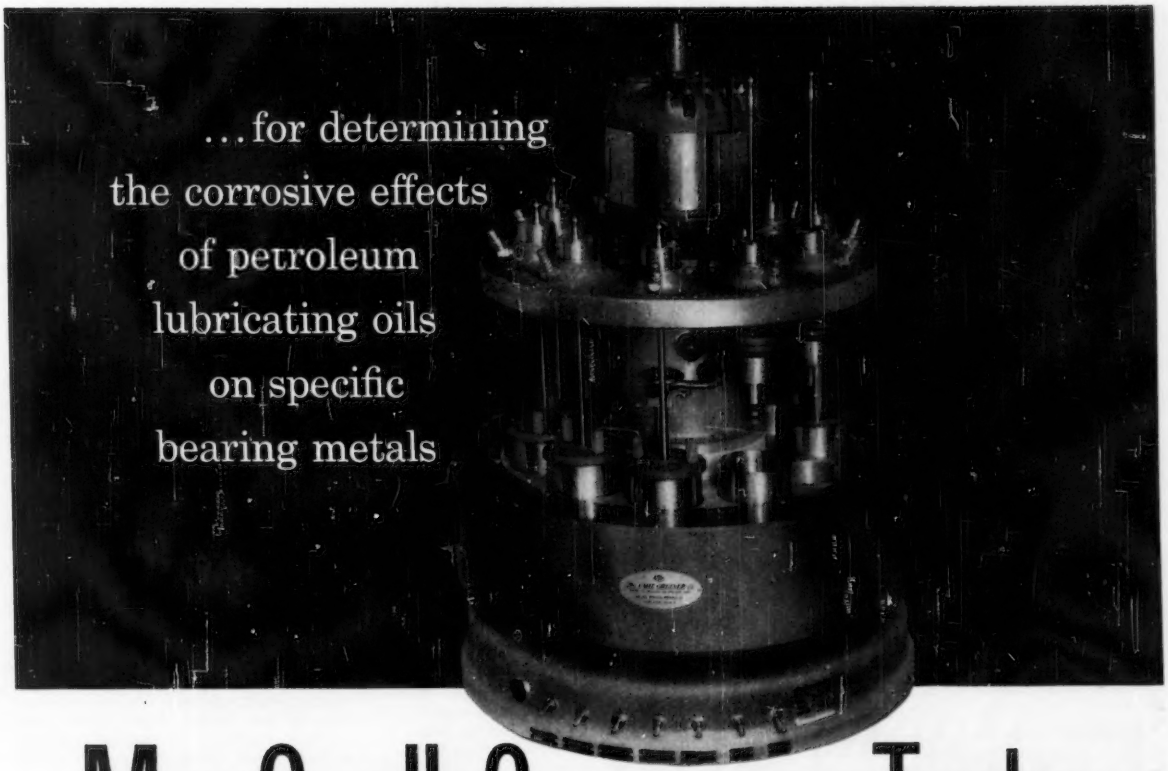
May 17–19—**American Institute of Industrial Engineers,** Annual National Conference and Convention, Shoreham Hotel, Washington, D. C.

May 22–24—**Association of American Railroads,** Annual Communications Section Session, Netherland-Plaza Hotel, Cincinnati, Ohio.

May 23–25—**American Society of Mechanical Engineers and Engineering Institute of Canada,** Joint Meeting, Mt. Royal Hotel, Montreal, Que., Can.

May 24–26—**National Society of Professional Engineers,** Annual Meeting, Ambassador Hotel, Atlantic City, N. J.

May 28—30—**Chemical Institute of Canada,** Annual Conference, Mt. Royal Hotel, Montreal, Can.



MacCoull Corrosion Tester

The MacCoull Corrosion Test is a laboratory procedure used for determining the corrosive effects of petroleum lubricating oils on specific bearing metals when the test oil is oxidized in air at an elevated temperature in contact with a catalytic surface. As it is desirable in the MacCoull Corrosion machine to reproduce the conditions which actually exist in an engine, namely, circulation of oil through a rotating bearing, spraying it into the air, contacting a catalytic surface, and recirculating through the bearing, these stipulations were maintained as much as possible in the design of this corrosion test machine.

The apparatus as illustrated is constructed of an aluminum block with ten beaker wells. Cartridge heaters are inserted into the bottom of the block for uniform heat distribution to each beaker well. The lead wires from the cartridge heaters run to a commutator plate between the heating block and the base block which permits rotating the heater block through an arc of approximately 350 degrees. Toggle switches inserted in the aluminum base plate operate the various banks of heaters, to obtain test temperatures of 350° F. In addition a thermoregulator circuit and relay control are also installed in the bottom compartment of the base. The top aluminum deck is equipped with a 1/3 horsepower heavy duty ballbearing motor which drives the ten test spindles through a belt and pulley arrangement. Each individual spinner is equipped with a ballbearing race and operates at a speed of 3000 RPM.

The assembly as illustrated comes complete with ten spinner assemblies, stationary baffle plates, split micarta bushings, stainless steel beakers, splash guard and beaker covers. Suitable for operation on 115 volts, 60 cycles single phase A.C.; current capacity 26 amp. Other voltages and frequencies to special order.

PRICE LIST

G18730	MacCoull corrosion test apparatus complete as described above	**each $2,750.00**
Accessory parts:		
G18731	Spinner assembly including spinner cover and spindle	**each 65.00**
G18732	Bushing, split micarta	**each 4.75**
G18733	Stationary base plate complete with copper baffles	**each 37.50**
G18734	Micarta beaker cover complete with splash guard and chimneys	**each 22.50**
G18735	Test bearings copper lead structure	**each .25 per 100 22.50**

We are also prepared to furnish the above apparatus with the MacCoull-Ryder modification (Pratt & Whitney Design) which incorporates a one piece spinner, stainless steel beaker with the stationary spindle machined as an integral part of the beaker. Price on request.

Send for "Labitems" describing MacCoull Corrosion Tester and other new petroleum testing instruments.

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FOR FURTHER INFORMATION CIRCLE 169 ON READER SERVICE CARD PAGE 121

NEWS NOTES ON
Laboratory Supplies and Testing Equipment

Note—This information is based on literature and statements from apparatus manufacturers and laboratory supply houses. The society is not responsible for statements advanced in this publication.

NEW PRODUCTS

Polyethylene Tanks—Designed for storing and mixing chemical solutions in laboratory or plant production applications. *American Agile Corp.* 1024

Automatic Clutch—Low-priced automatic clutch designed for $\frac{1}{6}$, $\frac{1}{4}$, and $\frac{1}{3}$ H-P electric motors. *Automatic Steel Products, Inc.* 1025

Radiation Shield—Adjustable lead shield designed for use in making radioactivity measurements on low-activity samples, and as a temporary storage area for dangerous radioisotopes. *Atomic Center, Inc.* 1026

Geiger Counter—For use by radiological civil defense personnel, it can also be used for general radiological protection in the laboratory. *The Atomic Center* 1027

Strain Gage—Bonded resistance-type strain gages made of metal foil for use at normal atmospheric temperatures. *Baldwin-Lima-Hamilton Corp.* 1028

Creep Testing Machine—New machine with different subassemblies, can be used (1) for long time creep tests, load being applied and measured by weights on a lever arm, and (2) for creep-rupture tests with motor-driven screw loading. *Baldwin-Lima-Hamilton Corp.* 1029

Thermistor Kit—New "see-easy" kit with 12 standard thermistors in a plastic compartment case for reference by engineers, designers, and technicians. *Bendix Aviation Corp.* 1030

Labstrobe—Small, light, inexpensive stroboscope unit, giving 60 brief flashes of light per second when connected to an ordinary 60 cycle power line. *Berkshire Laboratories.* 1031

Convection Oven—Automatically provides a constant air weight circulation at all temperatures, to give greater heating efficiency to 1200 F. *Blue M Electric Co.* 1032

Ultraviolet Microscope—Automatic color translating ultraviolet microscope for accurate structure determination and indication of absorption spectrum. *Boston Electronics Div., Norden-Ketay Corp.* 1033

Deviation Test Bridge—Designed to present accurately and quickly a comparison against a standard impedance indicating both percentage impedance deviation and phase angle deviation in radians on a 6-in. illuminated scale. *Brush Electronics Co.* 1034

High Vacuum Pump—Completely new high vacuum pump delivers a free air displacement of 20 liters per minute. *Central Scientific Co.* 1035

Pump Plate for Vacuum Evaporation—Steel pump plate, especially designed for experimental vacuum evaporation and sputtering of metals, antireflection and multilayer coatings, vacuum melting of metals, vacuum impregnation, and for small quantity production. *Central Scientific Co.* 1036

Single-Turn Precision Potentiometer—A simplified method of phasing multisection potentiometers is incorporated in the new Vari-Phase Precision Potentiometers. *Clarostat Mfg. Co., Inc.* 1037

One Ton Multipress—New press designed for cutting production costs on such operations as pelleting, compacting, testing, straightening, etc. *Denison Engineering Co.* 1038

Automatic Sampler—Automatic sampler with end carriage to provide accurate sampling results in normally inaccessible places. *Denver Equipment Co.* 1039

Mechanical Force Gage—A much needed device for controlling *mechanical* forces at various load points. *W. C. Dillon & Co., Inc.* 1040

Tension in Moving Wire—Determination of tension in moving wires can be determined with an answer that is not only ingenious but easy to duplicate in most any shop. *W. C. Dillon & Co., Inc.* 1041

Camera—For 3-in. CRT—Only oscillograph-record camera to be specifically designed for use with a 3-in. cathode-ray oscillograph. *Du Mont Laboratories, Inc.* 1042

General Purpose Oscillograph—First such instrument in the low-price range offering *identical* direct-coupled high-gain *X*- and *Y*-amplifiers and amplitude calibration on *both* channels, together with superlative stability. *Du Mont Laboratories, Inc.* 1043

Constant Air-Flow Fume Hood—Complete line of fume hoods is now available with *Constant Air-Flow*, permitting the hoods in the laboratory to function as definite parts of the air-conditioning system. *Duralab Equipment Corp.* 1044

Rotating Lab Shaker—A new variable-speed rotating laboratory shaker provides continuous, constant-speed rotary agitation at any setting from 125 to 350 rpm. *Eberbach Corp.* 1045

Pressure Transducer—Multipurpose pressure transducer, featuring a unique unitized construction providing easy assembly, calibration, and repair. *Fairchild Camera & Instrument Corp.* 1046

VHF Standard Attentuator—Precise measurement of attenuation in electrical elements over a frequency range from dc to 300 mc. *Federal Telephone and Radio Co.* 1047

Lab Wrap—To expedite the insulating of distillation columns in the laboratory and other equally hard-to-insulate apparatus, a new tape of plain, purified asbestos $\frac{1}{32}$ in. thick, in widths of 1, $1\frac{1}{2}$, and 2 in. *Fisher Scientific Co.* 1048

Infra-Red Heater—*Low-cost* infrared heater that should handle drying and evaporation more conveniently than ever before. *Fisher Scientific Co.* 1049

Coulomatic Titrimeter—Speeds determinations of mercaptans in petroleum products, also expedites a variety of other analyses. *Fisher Scientific Co.* 1050

Radioactive Chromatograph Scanner—New chromatograph scanner employs a small flow counter with low background and scans chromatograph strips up to $1\frac{1}{2}$ in. width and any length. *Ferro Scientific Co.* 1051

Fluorimeter—New Fluorimeter unit may be operated in conjunction with any photometric unit or color-difference meter, and serves as an additional exposure head for precise evaluation of the fluorescent intensity of dyes, paints, textiles (treated or untreated), and other products. *Gardner Lab., Inc.* 1052

Streamlined Desk—This 54- by 24-in. desk styled with rounded corners in the modern manner has two deep, full letter-size, file drawers, one in each pedestal, for desk-filing of correspondence and current "job files." *General Industrial Co.* 1053

Brake Motor—For use in precision instruments and other motor-operated devices where accurate control is required, a new fractional horsepower brake motor stops within 10 deg of rotation for final shaft speeds below 50 rpm. *Gleason-Avery, Inc.* 1054

Ball-Bearing Induction Motor—Use of ball bearing makes motor especially useful under rugged operating conditions and temperatures ranging from −40 to 130 F. *Gleason-Avery, Inc.* 1055

Test Jack for Etched Circuits—Etched and printed circuit engineers can now solve test point and monitoring problems, by use of a tiny test jack only $\frac{1}{4}$ in. O.D. and approximately $\frac{1}{4}$ in. high. *Grayhill Co.* 1056

Subminiature Push Button Switches—Ideal for computer and instrument application, where space is at a premium. *Grayhill Co.* 1057

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specialized testing equipment

Research Appliance Company specializes in producing precision-machined equipment for diversified uses in leather, plastics, oils, tars, etc.

For example, we have built:

- Tapping Test Units for a large steel corporation, (used for testing tapping oils).
- Extensometers, for measuring the elasticity of plastics.
- The Setchkin Self-Ignition Apparatus, for testing spontaneous ignition temperatures of combustible liquids.
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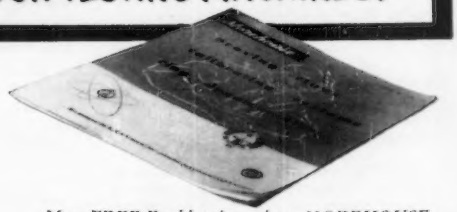
CIRCLE 170 ON READER SERVICE CARD PAGE 121

HOW ACCURATE ARE YOUR TESTING MACHINES?



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Snap Switches—Subminiature snap switches are the smallest dry gas filled hermetically sealed units on the market today. *Haydon Switch, Inc.* 1058

Flux Pot—A new unit specifically designed and manufactured for warming and controlling brazing and soldering flux. *Helmco, Inc.* 1059

Solderless Terminals—New-type solderless terminals and connectors give firmer and vibration-proof connections. *Hollingsworth Co.* 1060

Tempmobiles—For refrigeration only, heating only, or a combination of heating and refrigeration. *Hudson Bay Co.* 1061

Visual and Aural Signal for Control Systems—Signal box for both visual and aural remote alarm indication in control systems. *Industrial Instruments, Inc.* 1062

Direct Reading Spectrometer—Economical direct reading medium quartz spectrometer which brings to smaller producers of non-ferrous metals analytical advantages formerly enjoyed only by larger firms. *Jarrell-Ash Co.* 1063

Lead Testing Comparator—Fast, accurate inspection of screws, while on or off a machine, is accomplished with a new portable lead testing comparator. *Jerpbak-Bayless Co.* 1064

Small Organic Chemistry Laboratory—Bantam-ware kit is provided with ample basic components to enable fractionation, steam, atmospheric and vacuum distillation, chromatographic analysis, extraction, filtration, reflux, and separation. *Kontes Glass Co.* 1065

Electronic Computer—Smaller than an average desk, the LGP-30 possesses the memory capacity and problem solving ability of computers vastly greater in size and costing much more. *Librascope, Inc.* 1066

Valves—Rounding out in-stock line of solenoid-operated pneumatic and hydraulic valves, with announcement of the Model 40 Series, four-way valves. *Mar Vista Engineering Co.* 1067

Photosensitive Plates—Special trial kit containing all required supplies to produce finished photosensitive plates. *Metalphoto Corp.* 1068

Pneumatic Transmitter—Transmitter that can accurately measure either temperature or gage, as well as absolute pressure over narrow and wide spans. *Minneapolis-Honeywell Regulator Co.* 1069

Toggle Switch—Toggle switch with an "electrical memory," four-pole assembly with one pole for indicating which circuit was last operated. *Minneapolis-Honeywell Regulator Co.* 1070

Standard Reflections—Full line of standard reflections providing calibrated reflections for use in standardizing reflectometers or verifying the accuracy of slotted lines. *Narda Corp.* 1071

Gas-Flow Standard—Dual range instrument provided with two high precision all-metal flowmeter elements which may be individually connected to a single manometer. *National Instrument Laboratories, Inc.* 1072

Portable Metal Hardness Testers—Improved portable metal hardness tester that provides direct readings corresponding to Rockwell A, B, or C scales or Brinell medium or low scales. *Newage International, Inc.* 1073

260 KV X-Ray Radiography Unit—Radiography unit that fits into the trunk of an automobile and is designed specifically for rapid inspection of welds, pipe lines, power plant, ship and aircraft equipment. *North American Philips Co., Inc.* 1074

X-Ray Bearing Analyzer—Designed specifically for quantitative analysis of lead-tin alloy platings on crankshaft bearings. *North American Philips Co., Inc.* 1075

Scintillation Detector—Counter is expected to find wide use in clinical, research, and industrial laboratories where gamma-emitting radioactive isotopes are used. *Nuclear Instrument & Chemical Corp.* 1076

Analog Computer Type Dynograph—High-speed direct-writing oscillograph that has been designed especially for the write-out of analog computers, telemetering devices, and other similar low-gain applications. *Offner Electronics, Inc.* 1077

Trip Balances—New model includes box-end beam construction, recessed balance

(*Please turn page*)

(*Continued from page 115*)

adjustment nuts, angle view dial, self-aligning agate bearings, precision ground steel knives, angle view relief etched beams, etc. *Ohaus Scale Corp.* 1078

Height Master—Faster working, cost-cutting height gage. *Pacific Gage Co.* 1079

Handi-Mat—A handy means for providing chemical and mechanical protection to equipment and apparatus. *Palo Laboratory Supplies, Inc.* 1080

Distillation—Redesign of the Automatic Distillation Apparatus, an instrument which eliminates the tedium of repetitive testing chores in controlling the quality of refinery output. *Precision Scientific Co.* 1081

Gum Content—Developed primarily for determinations of the gum content of aviation and motor gasolines by the air jet method, the Two Unit Gum Bath is suitable for gum determinations of all aromatic and aliphatic petroleum distillate products in the distillation range below that of kerosine. *Precision Scientific Co.* 1082

Sealing Properties—Test jig is designed for the evaluation of the sealing properties (zero sealing point, initial sealing pressure, and conditioned sealing pressure) of rubber and rubber-like materials by ASTM test method D 1081. *Precision Scientific Co.* 1083

Flash Testers—Redesigned Pensky-Martens Flash Testers, in both electrically heated and gas-heated models. *Precision Scientific Co.* 1084

Multi-Channel Analyzer—A 256-channel analyzer based on the Argonne National Laboratory design has 256 windows and a count storage capacity of 2^{16} or 65,536 counts per window. *Radiation Counter Laboratories, Inc.* 1085

Conductivity Control—Electronic instrument for controlling the conductivity of solutions. *Robertshaw-Fulton Controls.* 1086

Film Badge Service—Film badge service for monitoring and protecting personnel exposed to radiation hazards. *St. John X-Ray Laboratory.* 1087

Dalin Coil Condenser—Because of unique construction, it is claimed that the possibility of valuable products of a synthesis spurting through the top of a flooding reflux condenser is completely overcome. *Scientific Glass Apparatus Co., Inc.* 1088

Ceramic Magnets—A low cost, ceramic permanent magnet material which combines adequate energy product with high coercive force, low residual induction, virtually 100 per cent electrical resistivity and exceptional resistance to demagnetization. *Stackpole Carbon Co.* 1089

Portable Temperature Test Chamber—Completely portable and self-contained, the new model is a low cost unit especially designed for production line tests of small products such as basic instruments, electronic subassemblies, mechanical components, etc. *Statham Development Corp.* 1090

Bench Type Brinell Hardness Tester—New low-cost motorized Brinell hardness tester, is said to combine operating economy with simple operation and dependable accuracy. *Steel City Testing Machines, Inc.* 1091

Tension Meter—Safely measures tensions up to 20 lb during the processing of wires, cables, coils, cords and other filamentous materials. *Tensitron, Inc.* 1092

Silver-Cadmium Cell—A revolutionary new battery, combining the weight and size advantage of a silver-zinc couple, with the long life characteristics of a nickel-cadmium couple. *Yardney Electric Corp.* 1093

CATALOGS AND LITERATURE

Chemical Resistance—The largest, most comprehensive list showing compatibility or noncompatibility of reagents to such thermoplastic materials as polyethylene, nonplasticized polyvinyl chloride, high-impact polyvinyl chloride. *American Agile Corp.* 2015

CO_2 Analyzer—New folder describes infrared CO_2 analyzer. *Beckman Instruments, Inc.* 2016

68-Page Catalog—For analytical and general research laboratories, pilot plant and production, a new 68-page, hard-bound, two-color catalog on electric ovens, furnaces, water and oil baths, and humidity cabinets. *Blue M Electric Co.* 2017

Chempumps—Four-page, two-color *Bulletin 1020* gives full information on newest addition to line of seal-less "canned" motor centrifugal pumps. *Chempump Corp.* 2018

"Canned" Motor Pumps—*Bulletin 1030* describes new low cost Series S Chempumps, latest addition to the line of seal-less centrifugal pumps. *Chempump Corp.* 2019

Centrifuges—Fully enclosed, eliminating hazards due to flying broken glass (*Bulletin 40*). *Chicago Surgical & Electrical Co.* 2020

Seamless Metal Cans—Illustrated, 3-color, 4-page bulletin describing the wide variety of seamless metal cans for pharmaceutical, laboratory, production line, and packaging use. *George D. Ellis & Sons, Inc.* 2021

The Laboratory—Spring 1956 number of *The Laboratory* for those "interested in the latest developments in laboratory instrumentation and technique." *Fisher Scientific Co.* 2022

Spectranal—*Bulletin FS-258* describes a moderately priced instrument for the qualitative and semiquantitative analysis of 61 elements. *Fisher Scientific Co.* 2023

Flexibility—*Newsletter No. 14* describes the new General Electric Impact Flexibility Tester. *Gardner Lab., Inc.* 2024

Vacuum Distillation Unit—Leaflet covers a specialized apparatus produced to meet the requirements of reduced pressure distillations of petroleum products according to ASTM method D 1160. *Glass Engineering Laboratories.* 2025

Spectrographic Supplies—Catalog contains 13 pages of listings of special pure materials and alloy standards; other listings cover carbon and graphite rods and powders; preformed electrodes; photographic plates, film and processing chemicals; lists of texts and reference books. *Jarrell-Ash Co.* 2026

Circulating System—For circulating tempered water or oil through refractometers, distillation columns, spectrophotometers, and other devices requiring constant temperature, *Bulletin No. 3052. Labline, Inc.* 2027

Review of Laboratory Apparatus—*Lanco Apparatus Review No. 6*, describes and illustrates 1955's best sellers in the line of laboratory apparatus. *Arthur S. LaPine & Co.* 2028

Read and Record Heads—For air-borne data-handling systems, computer memory systems and for laboratory testing. *Librascope, Inc.* 2029

Homogenizers—New 6-page *Booklet H-55* on the use and selection of industrial homogenizers. *Manton-Gaulin Mfg. Co., Inc.* 2030

Pressure Controller—*Bulletin 7040* describes new small-case indicating pressure controller available in ranges from 0 to 50 to 0 to 200 psi. *Minneapolis-Honeywell Regulator Co.* 2031

Tel-O-Set Indicators—*Bulletin 7202* describes the new Tel-O-Set vertical scale indicator, used to measure and control process variables such as temperature, pressure, flow, and liquid level. *Minneapolis-Honeywell Regulator Co.* 2032

Flowmeter—*Specification Sheet 242-2* describes mechanical flowmeters with evenly graduated charts and scales. *Minneapolis-Honeywell Regulator Co.* 2033

X-Ray Diffraction—New literature describing how metallurgical problems are solved with X-ray diffraction. *North American Philips Co., Inc.* 2034

Proportional Counting—*Proportional Counters* compares six types of proportional counting systems used in the laboratory for measuring radioactivity. *Nuclear Measurements Corp.* 2035

Palo Retort—A 16-page publication describing many new laboratory products recently marketed by Palo. *Palo Laboratory Supplies, Inc.* 2036

O-Ring Sizes—12-page *catalog 5701* contains cross-reference charts of size numbers with dimensional data for all Parker O-rings for sealing applications. *Parker Appliance Co.* 2037

Rotational Viscometer—*Data Sheet 10911* on the Precision-Interchemical Rotational Viscometer, an instrument for determining the viscosity, yield value, and thixotropic breakdown of highly viscous materials. *Precision Scientific Co.* 2038

Wheel-Bearing Grease Tester—*Bulletin 718* on the redesigned Wheel Bearing Grease Tester, an apparatus for determining the leakage tendencies of wheel bearing greases according to the ASTM method D 1263. *Precision Scientific Co.* 2039

Evaporation Test Cell—*Bulletin 719* on the Evaporation Test Cell, the only com-

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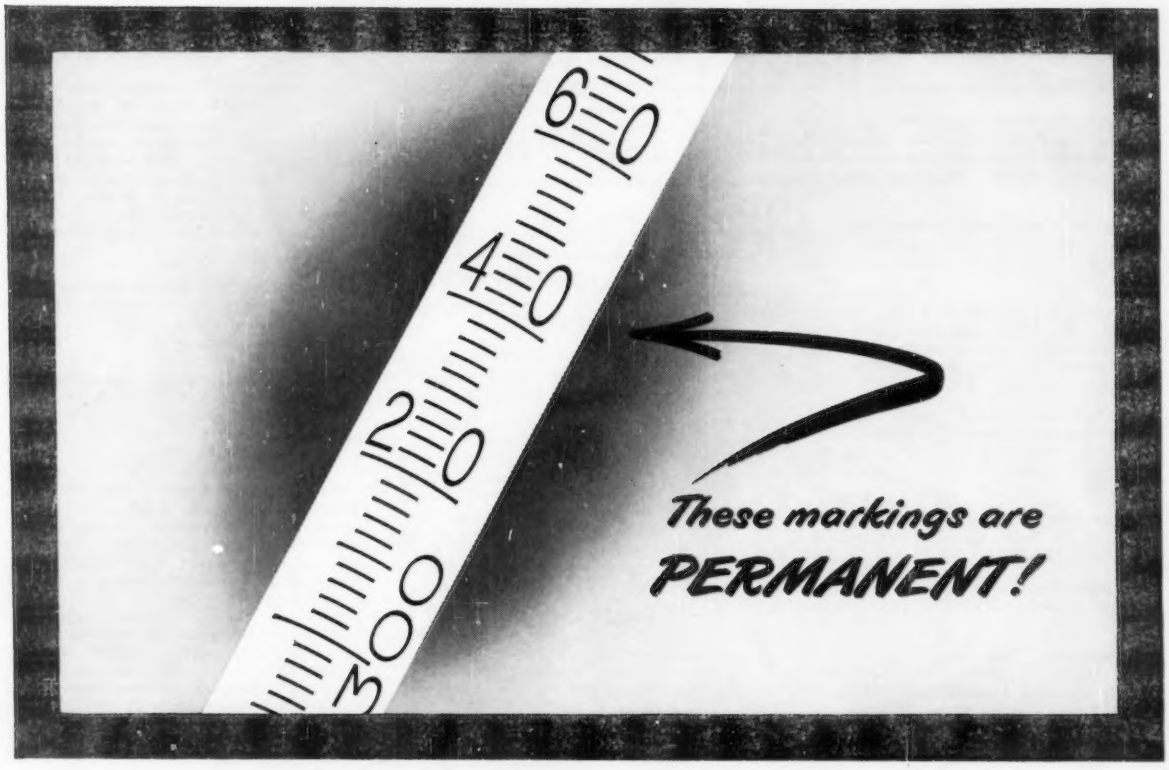

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(*Continued from page 116*)

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Thermo-Regulators—*Bulletin 649* on sealed contact thermo-regulators both adjustable and pre-set models. *Precision Scientific Co.* 2041

Accidental Scientific Discoveries—Twenty important scientific discoveries are interestingly described in a new 64-page booklet entitled, *Accidental Scientific Discoveries. Schaar & Co.* 2042

Surfactants—Drastic and dramatic modifications with surfactants can improve products, reduce processing costs, and enhance business potential. *Foster D. Snell, Inc.* 2043

Fluid Flow—"Alternating Flow of Fluid in Tubes," *Instrument Notes No. 30. Statham Laboratories, Inc.* 2044

Pumps—For medium and high head services (*Catalog A 155*). *C. H. Wheeler Mfg. Co.* 2045

Laboratory Furniture—Twenty-eight basic units of metal sectional laboratory furniture adapt themselves to virtually every type of new laboratory planning, expansion, or change. *Will Corp.* 2046

Glassware for Electronics—Four-page, two-color brochure featuring the use of precision glassware for electronic applications. *Wilmad Glass Co., Inc.* 2047

INSTRUMENT COMPANY NEWS

American Instrument Co., Silver Spring, Md.—James M. Klaasse joins American Instrument Co. as Chief Engineer.

Atlas Electric Devices Co., Chicago, Ill.—Announces the appointment of two new West Coast representatives who will handle both sales and services of Atlas Fade-Ometers, Weather-Ometers, Launder-Ometers, and related equipment. John K. Bice Co., will represent Atlas in southern California. In northern California Atlas will be represented by Pacific Coast Chemicals Co.

Central Scientific Co., Chicago, Ill.—Central Scientific Co., one of the largest manufacturers and distributors of scientific instruments, laboratory apparatus and chemicals, is opening a new branch at 3232 11th Ave. North, Birmingham, Ala.

Consolidated Electrodynamics Corp., Pasadena, Calif.—New advanced Electronic Data Laboratory will undertake development of advanced equipment in the magnetic-tape data-processing field under contract to governmental and private agencies. John P. Moffat, Jr., has been promoted assistant director of quality control, Consolidated Electrodynamics Corp.

North American Philips Co., Inc.—The Research & Control Instruments Division has established a new office at 96 Bloomfield Ave., Newark, N. J.

Nuclear Development Corp. of America, White Plains, N. Y.—Walter A. Hamilton has joined Nuclear Development Corp. of America (NDA), White Plains, N. Y., nuclear engineering firm.

Robertshaw - Fulton Controls Co., Greensburg, Pa.—In order to insure high quality of its products and to develop new production techniques, American Controls Division of Robertshaw-Fulton Controls Co. has established a unified engineering department at its St. Louis plant. The newly created engineering department brings under single direction all testing and quality control functions at the division. In addition the department will develop its own engineering data, which were formerly provided by other company divisions.

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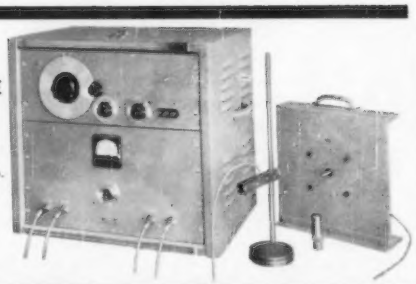

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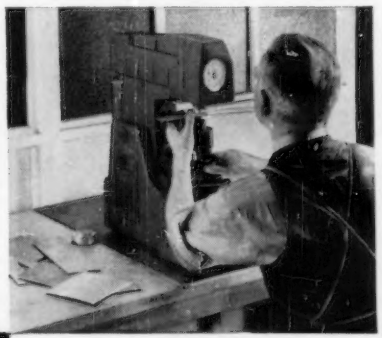

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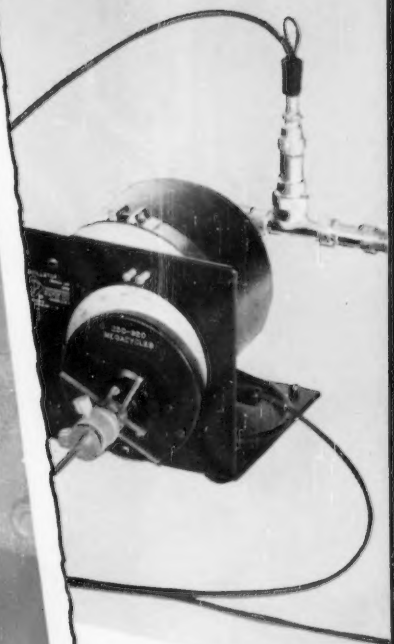

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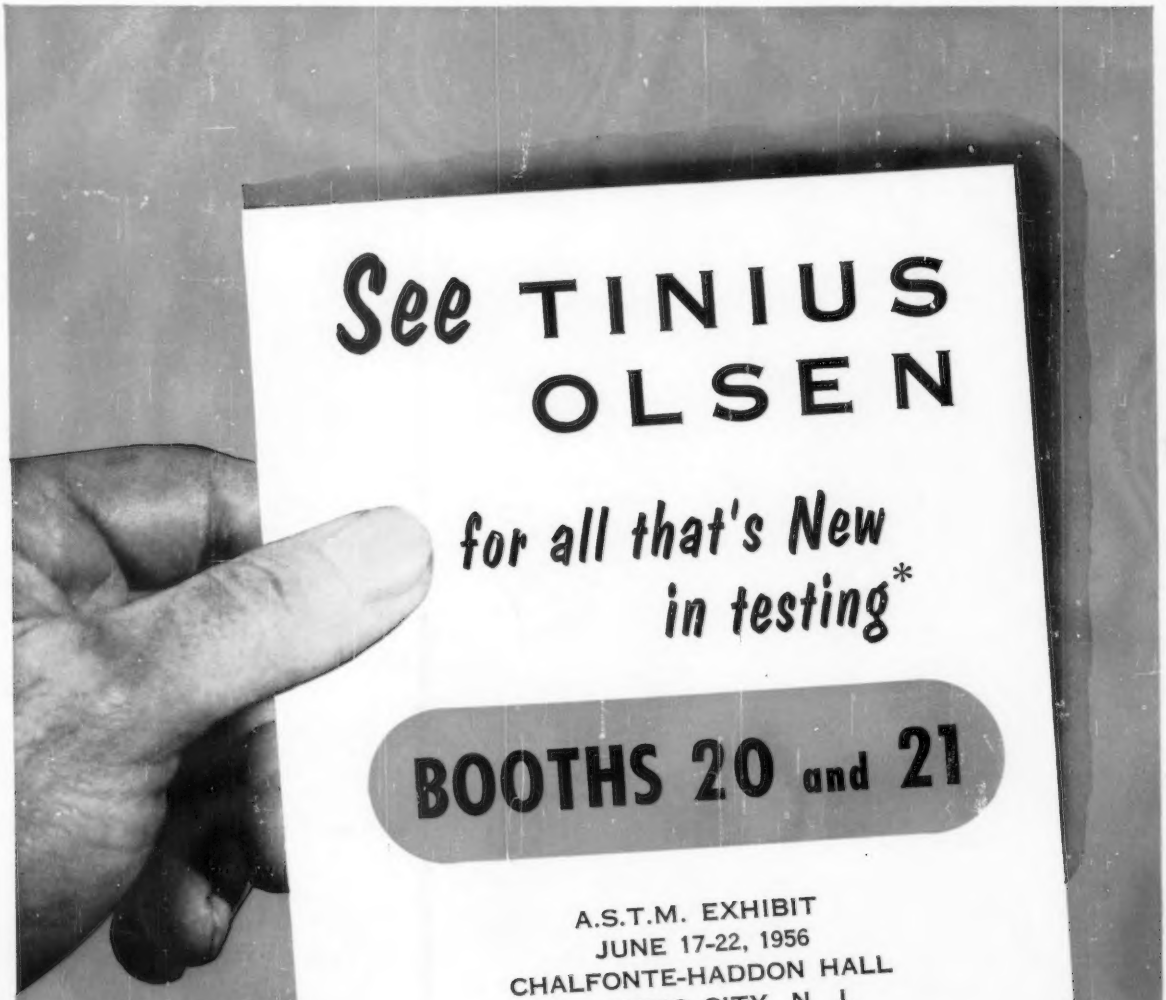

*. . . new machines for research and production testing plus new instrumentation will be featured.

Put Tinius Olsen on your "Must See" list . . . or, if you can't attend, write for information about the machines to be shown.

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